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PARACHUTING MARINES . . . Page 3

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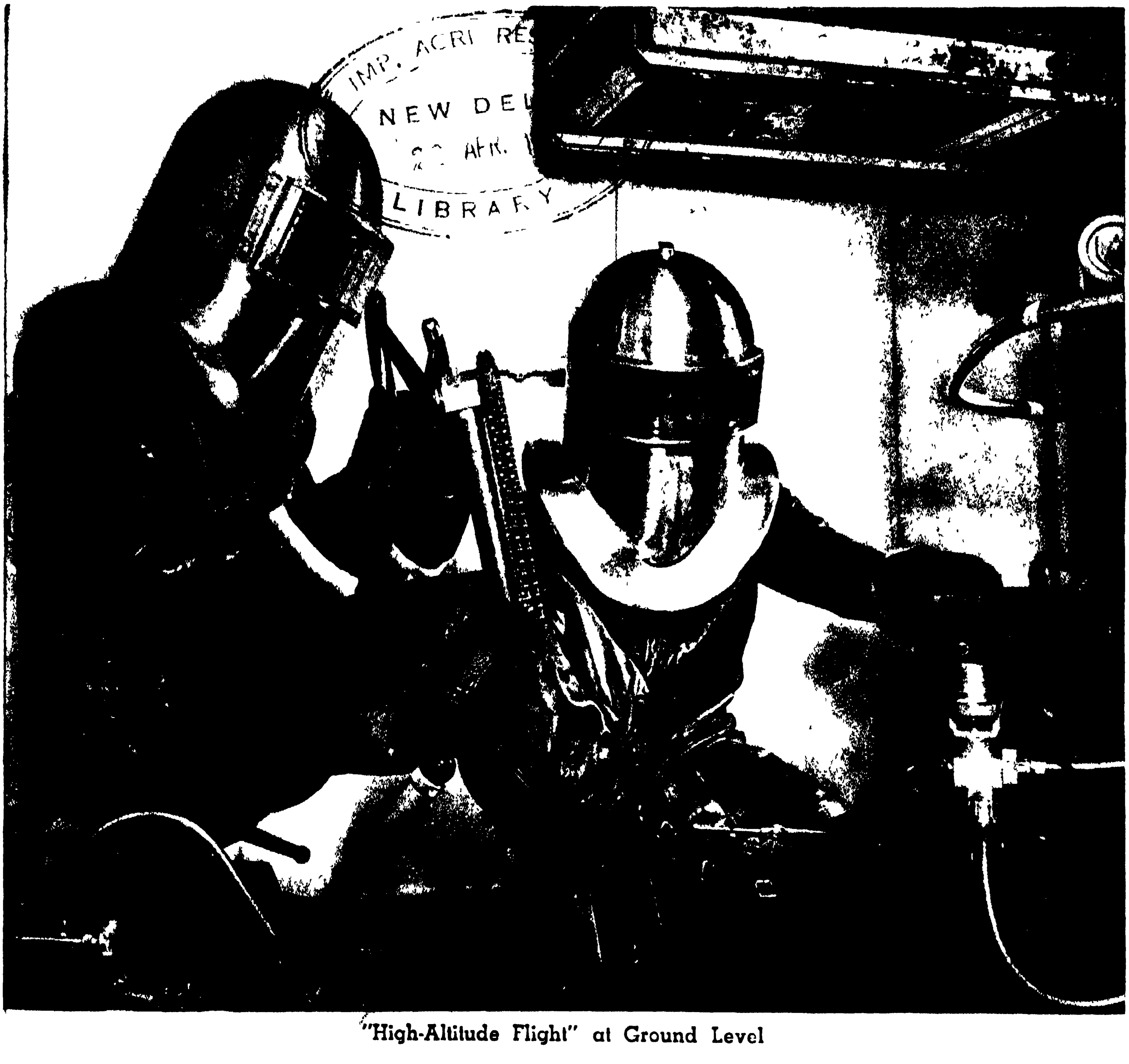

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SCIENTIFIC AMERICAN

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NINETY-EIGHTH YEAR • **ORSON D. MUNN, Editor**

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IN THE "cold room" used for aeronautical research at the Douglas Aircraft Company's plant in Southern California, these strangely dressed engineers are conducting research on high-altitude flying equipment. In this room, described in more detail on page 27, the conditions and effects of extremely low temperatures can be studied at leisure under controlled conditions.

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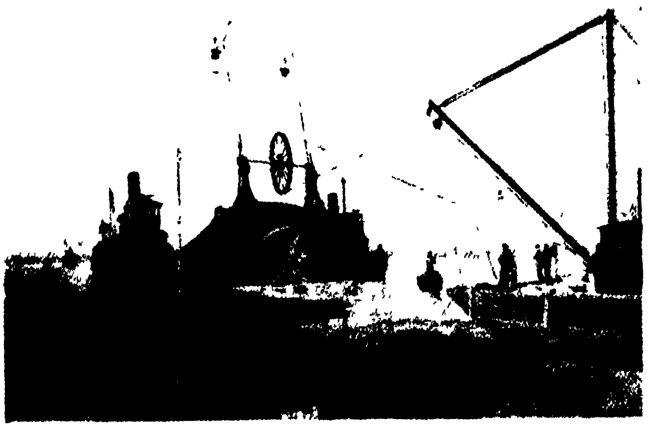
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of January, 1892)

NAVY—"Our navy, as regards material, ships, armor, and ordnance, today is in the first rank among nations. All that is now needed is more ships and proper crews. The ships are being rapidly built. Congress might supplement the work so well in progress by providing for the improvement of the status of recruits, thereby securing intelligent and superior men for the naval service"

TUNNELING—"A method of constructing tunnels under rivers whose beds are of mud, clay, silt, or sand is shown in the illustration. A sectional iron tube is sunk in a cut dredged for it, leveled, topped with clay or concrete in bags, the cut filled in and working shafts built around the ends. The tunnel tube is then pumped out and bricked up by sections, a roadbed made and junction effected with approaches."



FLEXIBLE GLASS—"Herr Eckstein, an Austrian engineer, claims to have discovered a strong and flexible substance, as transparent as the ordinary brittle glass . . The material obtained is said to resist the action of salts, alkalies, and acids, and besides being transparent is odorless. It is flexible, and almost unbreakable. . . Any color or shade may be imparted to the new glass."

POWER—"After the completion of the great tunnel works now in progress at Niagara Falls, there will be nothing to hinder the rapid rise and growth of that interesting town into a great and wonderful city. Its dwellings and factories will be supplied with light, heat, and motive power at an extremely low cost, and useful industries of every kind ought there to flourish with unwonted vigor"

CABLE—"The Bahama Islands are soon to be connected with the general telegraphic system of Great Britain and the world. A submarine cable about 200 miles long will be laid from a point about five miles from Nassau, New Providence, to a point about the same distance from Jupiter Inlet, on the southeast coast of Florida."

INSANE GENIUSES?—"Men of genius have not, as a rule, been mad, except with an insanity of a scientific and scholastic kind, such as the world really needs more of. The eccentricities, monomanias, and emotional exaltations of genius have been incidental, and were not the basis of their character and temperament. . . Insanity is a condition in which the power of adjusting one's self and one's conduct to the environment is lost. Surely there is no loss of this kind shown in the work or conduct of men of genius."

"TELETYPESETTING"—"The management of the *London Times* has utilized the telephone in a unique way Telephone wires have been laid in the underground railway tunnel between the composing room in Printing House Square and the Parliamentary reporters' gallery in the House of Commons. A copy reader placed at the telephone reads the stenographic 'turns' from the note book as fast as it is possible for the compositors to take them on their typesetting machines in the Times building, a mile and a half away."

SAILING—"The demand for sailing vessels has, of late, shown a marked increase both here and abroad; in Great Britain, according to Lloyd's Registry, there being now 141 such craft with a total tonnage of 185,807 under construction against 76 with a tonnage of 80,000 this time last year. Here about the same tendency is manifest. The rate of steamer construction in Great Britain has seen a marked falling off during the year, and though in these waters the rate has largely increased, it may easily be traced to favorable legislation rather than to a further abandonment of the sailing type."

RAIN MAKING—"Nearly all the accounts of the recent rain making experiments in Texas appear to have emanated from, or to have been inspired by, persons who took part in the performances. These reports were, in most instances, grossly exaggerated, and, in some cases, wholly destitute of truth. . . It is understood that an attempt will be made to induce the present Congress to appropriate more money to carry out another series of these foolish fireworks."

CLOGS—"There is a considerable demand for wooden shoes in this country, especially in the Western States and Territories. They are worn by those who have become accustomed to the use of that kind of foot covering in the land of their birth and have not yet adopted the shoes generally worn here, and they are also used by persons who are employed in damp, sloppy places."

SPEED—"On a recent run by a Baldwin compound on the Baltimore & Ohio, hauling a 'Royal Blue' train from Philadelphia to Canton, on December 22, 1891, the time, including one stop at Wilmington and a slow-down at the Susquehanna bridge, requiring three minutes in crossing, was 101 minutes for 91.6 miles."

FORCE—"Man can neither create forces nor endow anything with properties. All that he can do is to convert and combine them into utilities. The man that does this with knowledge is spared the dismal failures of ignorance, but he that tries to use powers without understanding them is inevitably punished for his rash presumption. It is this presumption that causes the mortality and disease that follow in the wake of civilization. Natural law, like the civil, never admits ignorance as an excuse."

98TH YEAR
SCIENTIFIC AMERICAN
JANUARY 1942

'THE MARINES HAVE LANDED...'

A New Way to Have the Situation Well in Hand

A. D. RATHBONE, IV

"COMING on the range!"

In fifteen seconds or so you'll make your first parachute jump! You, Private, First Class, Smith, of the United States Marine Corps, are going to throw your perfectly good body out of a speeding plane at a 1000-foot altitude—and hope to God your parachute opens!

Ever since the training ship took off five minutes ago—an eonic five minutes—you've been in a fog of apprehension. You're as tense as a fiddle string; your hands are clammy; there's a trickle of cold sweat down your spine — but you've laughed and joked with the 11 other neophyte jumpers who are with you in the plane, the lads with whom you've trained four weeks for this moment. Boastfully, you've held out your hand to display steady nerves—and you wonder if they, too, saw it shimmy.

But the jumpmaster's warning command has snapped you out of it. Emphatically dinned and oft-repeated instructions come back to mind in clear, logical order. They disperse that mental haze. You're all hastily untangling legs from sitting positions; you're scrambling to your feet and to your places on the static cable. Static lines are snapped to the cable; left fists grip the clasps 'til knuckles whiten.

"Stand by!"

Here it comes! Another second or two and you'll—

"GO!" shouts the jumpmaster above the roar of the plane's motors, and he slaps the first man on the back and out of the jumping port in the tail of the ship. Swiftly the next man steps up—he's gone!—the next, and the next --you are number seven, lucky seven, you hope—another and another—and you're at the jumping port—with Lilliputian pine trees and roads like strings 1000 feet below!

In that infinitesimal instant in which you're poised on the brink of space, your mind works — works faster and with greater clarity than you had thought possible. In lightning succession you recall that you must let go of your static line; that if the static line doesn't open your troop 'chute, you must grasp the rip-cord ring of your Reserve Training 'chute, cradled like a baby at your chest, with your right hand and pull — pull like hell! — and it's comforting to recall that as yet no initiate into the Leatherneck parachute troops has had occasion to use this safety 'chute—and then — there's nothing solid under foot. You're falling through space!

NATIONAL DEFENSE

● **Material for this article was obtained through the co-operation of the United States Marine Corps. Permission to visit the Marines in training at Lakehurst Naval Air Station was granted by the U. S. Navy.** ●

Many months ago, when official announcements calling for volunteers for parachute training were tacked on bulletin boards at Marine Corps bases everywhere, hundreds of pairs of eyes eagerly scanned the strict qualifications necessary to enter this adventurous service. The applicant had to be a member of the Regular Marine Corps, or Marine Corps Reserve, with a minimum of six months service behind him and at least a year to go, or else to express a willingness to extend the future service. He had to be between the ages of 21 and 32, unmarried, athletically inclined, well proportioned. He must weigh between 140 and 180 pounds and be not less than 68 nor more than 72 inches tall.

Reading on, you would have learned that volunteers who qualified would receive an extra $50 per month, and you might well have murmured to yourself, "Hmm!" No doubt you would have wondered what the sensation would be, if you flung yourself into space with nothing but a neatly packed silken canopy strapped to your back.

Then, if you had read the order further, you would have found these words: "The nature of the duty involved requires initiative, determination, agility, and strength, and a military and educational background that will qualify men for technical duties of a hazardous nature."

IT'S JUST possible that that "hazardous nature" business would have tipped the scales of your youthful Leatherneck mind in favor of volunteering, for the entire 166-year history of the United States Marine Corps is profusely interwoven with brilliant deed-threads that spell "hazardous nature"—and, after all, one doesn't join the Marines to learn how to knit! Had you suited action to thought, your formal application would have been addressed to the Major General Commandant via the customary official channels. Accompanying it would have been a statement covering your service, educational record, athletic expe-

Scientific American Photos, approved by U. S. Navy

Fledgling Marine Paratroops about to make their first jump

rience. There was also a rigid physical examination in which the medico directed special emphasis toward freedom from organic heart disease, medical history of ankle, knee, or hip injury, if any, and systolic and diastolic blood pressure. In addition, there was a modified flight physical check-up on visual acuity, binocular vision, depth perception, and flight-ear examination as well as a test of equilibrium faculties

If, by chance, you had grown a bit cocky over the physical perfection you had demonstrated for the benefit of the doctors, you would have had that nonsense knocked out of your system in an exceedingly "blitz" manner soon after reporting to Lakehurst Naval Air Station, along with other "perfect" lads from every state in the Union. Your six-week course of training, you would have found, had been arranged in three extremely strenuous periods of two weeks each. The first phase covered conditioning exercises—and were they "conditioning exercises!" They left you, at first, feeling as though you were a worn-out old rooster of 35 years, or so, who just couldn't take it any more. There was also an intensive course in parachute nomenclature and packing instructions; a study of landing methods, including harness training, platform jumping, and practice exits from dummy planes. You learned to roll and tumble around on the ground, like a circus acrobat, with muscles relaxed instead of tightly drawn.

The second two weeks covered more—bigger and better, you might say—conditioning exercises, with more rolls, more tumbles, more back somersaults. There was tower training, which meant utilizing an apparatus comparable to the New York World's Fair parachute jump, a drop of 125 feet in a 'chute guided by control cables. Then came more jumps from a similar apparatus, known as the "fly-away" tower, because the parachute you leaped with was pre-opened before the jump and was held that way by steel ribs, like an umbrella, but there were no guiding cables to direct you or control your landing. It was here, they told you, that a man really proves his readiness for the final phase of jumping from the 'plane. Along with these came parachute packing instructions and study of wind-drags, which included methods of controlling the 'chute through manipulation of the shroud lines.

The final, and most exciting two-week training period included a sort of post-graduate course in those ever-present conditioning exercises. By now they'd built you up from 20 to 45 minutes of exceedingly strenuous calisthenics early every morning except Sundays, with emphasis on leg and abdominal muscle development, capped by a brisk run, which was a half mile long to begin with and had gradually been extended to one and one-half miles. There was further training in parachute care and packing and, at long last, squad jumping from a plane in flight—which had resulted in your stepping off the edge of the plane's jumping port in the general direction of those Lilliputian pine trees and string-like roads, 1000 feet below

The type of jump you've just begun is known as a "static line fall." Because of the mechanics of the static line, and in contrast to a "free fall" and a "delayed jump," this form of leap may be made from a plane as low as 250 feet in actual war-time operations. This short jump places men and equipment more closely together when they reach the ground, spots them nearer their objective than would a longer drop, and, falling at from 16 to 23 feet per second, offers the enemy far less time to attempt to make targets out of the landing force from the sky. As indicated by the terminology, the latter two types of jumps do not involve use of the static line, that stout, 13-foot strip of two-inch canvas webbing which is such an all-important factor in your present predicament

Your fastidiously packed 'chute reposes in that canvas container strapped to your back. The static line is folded against itself several times and is held in place on the outside of the pack by two loops of elastic webbing. It terminates in a large, metal snap which, at that command, "Coming on the range!" you hooked onto the static cable that is strung lengthwise of the plane. The other terminus of the static line acts as the rip cord, tearing open the fastenings on the pack so the pilot 'chute can per-

Static cable fidgets

form its function of hastening the opening of your 28-foot troop 'chute. In other words, the static line is a mechanical rip cord which obviates the necessity of remembering to pull the rip-cord ring. If, for some reason, the static line doesn't perform, you grab the rip-cord ring of your reserve 'chute and—but why go into that? The static line has worked, the pack is ripped open, the pilot 'chute's released, and in a second or so you're going to receive the most severe yank or jerk your system probably has ever known

POSSIBLY veteran jumpers can describe sensations and thoughts during the brief seconds that elapse between the leap from the plane and the teeth-loosening wallop that ensues when the 'chute opens and applies sudden brakes to a headlong earthward plunge, but to a neophyte that brief passage of time remains pretty much a blank. Although the parachute harness is designed to distribute the shock of opening to portions of the body best suited to absorb it, the comeuppance you receive when the 28-foot-diametered canopy abruptly goes to work is comparable to an almost instantaneous reduction of traveling speed from about 45 miles an hour to between 15 and 20 miles per hour In an automobile, such a drastic change of pace might be preliminary to a swan dive through the windshield; in a parachute harness, you have a fleeting sensation that your skeleton is about to slide feet-first out of your body.

Go! (Note static lines at jumping port)

Despite the hours and hours of rigorous preparatory training for this bump in midair—training in which you were hooked into a practice harness, raised by block and tackle to the hangar roof rafters, and allowed to drop 'til the ropes caught you up short—you're surprised and slightly dazed at the short free fall and its sudden cessation. But in an eye's twinkling you're back to normal—as normal as can be expected when, for the first time in your life, you find yourself suspended some 900 feet above earth by 28 silken cords that funnel out from your body to the fluted edge of a gleaming white canopy which hides the sky and your fellow jumpers above you, but which is permitting you to float easily and gracefully downward. Actually, you have the sensation of being poised motionless, with a gentle breeze blowing up your nostrils and whistling past your ears, while the ground comes up to meet you. It's an exhilarating feeling to realize you've made your first parachute jump—that you've actually done it and that everything's under control. You feel like shouting or singing—and maybe you do both

Now you begin to recall other instructions and more of your intensive training. You mustn't look up Always look down! Keep your eyes on the ever-approaching ground. There may be rocks, trees, other protuberances that would contribute to an uncomfortable landing, but which may be avoided if you study the terrain below and manipulate your shroud lines properly Those supporting ropes of braided silk, each with a tensile strength of 450 pounds, constitute the steering mechanism of your strange craft. If you want to drift further to the right, you reach up with both hands, grasp the shroud lines on your right side, and pull. This draws the gores of the 'chute downward, spills air out of the opposite side, and causes the 'chute to slide off to the right. The same procedure applied to the left, the front, the rear will motivate you in the desired direction, but don't slip too much air out—you might come down faster than good health dictates. All this, you know, you learned while practicing in a captive, stationary 'chute, suspended from the hangar rafters by wires, much like a gigantic umbrella.

Static lines are hooked to cable

THE ground's coming closer! Only a few seconds and you'll put practiced landing technique into operation. You recall the hundreds upon hundreds of training jumps you made from, first, the three-foot platform and, later, the eight-footer. The latter didn't prove much of a shock and you were told that, barring heavy winds or brutal ground conditions, your actual landing would be similar to such a jump. After all, you ruminate, an eight-foot jump, even onto hard ground, is kind of a sissy thing, so long as it's done correctly. You must land on the balls of your feet—never on your toes or flat on your heels. Let the legs spring naturally to take up the shock, and then pivot in the general direction of the wind. This puts you in a squatting-rotating position from which it is easy to follow through with that professional tumbler's back roll you practiced for so long. You simply ease down onto your buttocks, and with a continuous rolling motion in the general direction of the parachute, now falling onto the ground, you do the back somersault, and unless there's a strong wind, the 'chute will shortly collapse like a blown-up paper bag that has been smacked with the palm of the hand.

You're almost down! A couple of fellow Marines are running toward you to be ready with a helping

You're down—safely!

hand—just in case. You remember to reach up and grasp the shrouds on either side of you with both hands, for you're going to "break your fall" as much as possible by "chinning yourself" on the shrouds just before your specially clad feet hit old Mother Earth. Your toes wiggle anticipatorily in the soft leather of the rubber-soled, 10-inch high-tops. You recall having heard stories about broken ankles in the parachute training corps, and how the special shoes were reported to have steel braces for protection, but when your boots were issued to you, they were pliable, soft, and without the slightest trace of steel, and you learned that experiments had proved that the introduction of metal braces produced more injuries than occurred with normal shoes, equipped with rubber soles and the 10-inch uppers.

Ker-thump! You're down! You go into your roll—and, glory be!—it's a perfect landing! Your feet sting slightly and you whacked your head a bit as you rolled, but in the thrill of accomplishment you don't mind, and you scramble to your feet to greet the men who have been running to help you

So, your first jump is over, and with more prosaic things to do there may come a mental let-down, for, whether you've realized it or not, you have been as carefully prepared psychologically for your initial leap as you were physically. There'll be other jumps, plenty of them, but meanwhile, your first job is to care for your 'chute. With the assistance of a qualified rigger, you collect the shroud lines—a process known as "chaining"—roll up the whole business and get it up to the loft above barracks. There it is suspended by its peak while you and a dozen helpers grasp the fluted edges and "whip silk"—shake and snap the silken expanse to free it of dirt and extraneous matter. If it's wet, it must stay hung up until dry, for a wet 'chute opens slowly. Next, you and your packer will secure the peak to one end of a long table; you'll draw the shroud lines to the other end, check all 28 of them for twists and turn-overs. Again you'll "whip silk" to straighten gores and panels, and fluff it up to remove air pockets. No gentleman's valet, not even the incomparable Jeeves, could fold his master's clothes with greater care than you lavish on the rest of the packing process, but eventually the 'chute is back in its container, the static line is once more folded and secured, and you're ready to jump again

LATER, after more practice, there'll be squad-jumping in combat maneuvers, with preliminary study of terrain, objectives, imaginary location of enemy forces, airports, water systems, communication lines, and so on, to be demolished or taken over by a daring, fast-moving parachute force Armed only with an automatic revolver, the squad will float earthward, followed by cargo 'chutes which will transport emergency rations, first-aid supplies, folding bicycles, radio equipment, ammunition, grenades, rifles, machine guns, and mortars Each squad will practice landing as nearly as possible as a unit—the Marines have jumped 11 men from one plane in six seconds—and the instant each man is on his feet, he'll have his carefully rehearsed part to play in assembling attacking equipment. In an incredibly short time the squad is fully armed and is in action.

Yes, the United States Marine Corps is rapidly acquiring a new method of effectiveness. Shades of old Leathernecks "from the halls of Montezuma to the shores of Tripoli" may well be restless in their hallowed graves at sight of these super-youngsters carrying out the traditional Marine custom of being "first to fight for right and freedom" by dropping from the sky, but it merely will be the 20th Century equivalent of "The Marines have landed and have the situation well in hand"—this time, by parachute

• • •

Meet the Jeep

The United States Army's Answer to Schicklegruber's Panzer Divisions

JO CHAMBERLIN

IT WAS the second day of the battle of Louisiana. The invaders' tanks roared to the attack near the Sabine River. But the defending forces didn't yield; they didn't even dig in and wait. Their lightning-fast jeeps, towing anti-tank guns, raced into strategic positions, harassed the enemy's advancing tanks, out-maneuvered them, flanked them, cut them off, and cut them down.

The tanks retreated; that particular blitzkrieg was ended. Over and over again the Louisiana maneuvers demonstrated the amazing abilities of Uncle Sam's newest invention, the rugged jeep or bantam car. General George Marshall, Army Chief of Staff, says that it is our main contribution to modern war. A buck private told me. "The blitzbuggy carries more fighting punch per pound than any other army vehicle." A post-maneuver War Department statement of mass-production plans calls the jeep "sensational."

Our army's youngest, smallest toughest baby has many pet names: jeep, peep, blitzbuggy, jitterbug, beetlebug, iron pony, leaping Lena, panzer-killer. The names are all affectionate, for the jeep has made good. When it was only a year old, it stole the show in the vast Louisiana tank and anti-tank warfare.

I was standing in the hot Mississippi sun while Lieutenant Patrick Summerour, of Camp Shelby, explained the jeep. There were rows of them before us: American Bantam, Ford, and Willys auto makers are turning them out by the thousands. Army goal: 75,000 jeeps

In front of me was a car 11 feet long, 56 inches wide, 40 inches high—half the height of your family auto and three feet shorter. Weighing only 2200 pounds, the jeep is rugged with power, yet is small enough to be flown in army transport planes. It has no doors, but there are safety straps to keep you from being catapulted out as it tears up and down steep slopes or around hair-raising turns. Normally it carries two passengers in front, one behind. In an emergency it can carry six, the extra men riding on flat front fenders. There are six speeds forward and two reverse. In deep mud, sand, or snow, power can be transmitted to all four wheels.

Lieutenant Summerour lifted up the hood.

"See that engine? Four cylinders Sixty horsepower. Plenty o' zip, and easy to fix because of standard parts."

He pointed to a rear towing hook

"You pull an anti-tank gun here Civilians often ask why we do not fight tanks with tanks. The answer is twofold. In the first place, a jeep costs $900, a tank $35,000. Second, these tank-destroyers, towing anti-tank guns, can swarm round old Shicklegruber's tanks and give 'em hell. It's like David and Goliath—only there are ten Davids for every Goliath "

NO ONE man developed the jeep In the fall of 1940, when the Army was about to buy a large number of motorcycles, the American Bantam Car Company offered the basic idea. Unenthusiastic, the Army nevertheless allotted funds for experimentation and later purchased 1500 cars. General Marshall himself promoted the venture. The first car was delivered in 49 days and proved itself under stiff Quartermaster Corps tests at Camp Holabird, in Maryland. The Corps added ideas. The manufacturers now turn them out wholesale from standardized blueprints.

Designed merely to replace the motorcycle, gruelling tests showed that the jeep could fight as well as run. And it could go places a motorcycle couldn't. Besides, a motorcycle dispatch rider is vulnerable; a single sniper can cut him down, letting vital orders fall into enemy hands. A jeep, carrying armed men and machine guns, is a far tougher proposition. And, vital for combat strategy, the jeep is a clawing, climbing hellion in reaching good places to shoot from

Photo by U S Army Signal Corps

Steep grades, sand, other tough going are trivia to a "blitzbuggy"

Lieutenant General Walter Krueger, commanding the Third Army in the Louisiana maneuvers, used the jeep for reconnaissance and command work. It can also serve as a radio patrol car. At Fort Benning, Georgia, it has laid smoke screens to hide the movement of heavy artillery. During battle it can take ammunition, first aid, or food to outposts, can evacuate wounded or get a gun crew out of a doomed position. It can cross bridges too weak for other cars, can reconnoiter rougher terrain With a mounted 50-caliber machine gun, it can help protect troop columns from airplane strafing

The War Department has just formed, at Fort Benning, the first air-borne infantry battalion. Planes will transport troops equipped with jeeps, motorcycles, and folding bicycles. The battalion will follow close on the heels of parachute troops in air landing operations

In Mississippi, I learned first-hand what it was like to ride in a jeep across pine-studded acres at 50 miles an hour. I learned, also, that much of its effectiveness depends on the driver's boldness and ability. It was like driving a Model T Ford across a ploughed field. I was riding a steel bronco, held loosely in my seat by a safety belt. Lieutenant Summerour rocked easily beside me as though cantering his horse in Central Park, apparently enjoying the ride.

He slowed down our jeep and straddled a half-buried log, front wheels tilted to the sky. I visualized a shattered crankcase but was shown guard bars underneath for just such protection. Grabbing special handles on the body, we lifted the car and shoved it easily off the log

ARMY strategists especially admire the jeep's "low silhouette " Only three and a third feet high, the jackrabbit-like jeep is hard to spot in brush country, still harder to line a gun on.

"Let's take a tactical problem," suggested Summerour as we were driving along. "S'pose we are out in front, scouting the enemy, and he fires on us from a hidden position—we dive for cover, —fast!"

He slammed on the brakes, turned sharply left, and stopped the car behind a protective knoll.

"Then we locate the enemy fire," he went on, "and blast him. We're so darned low it's hard for him to see us."

At 25 miles per hour he headed for a huge live oak with gnarled branches close to the ground. I was expecting him to swerve suddenly to demonstrate the jeep's maneuverability. Soon I saw that it was not his intention to swerve at all.

"Duck!" he yelled.

I ducked.

We roared under the lowest branch—the top of our car missing it by inches. Only then did I realize that I had stowed my 190 pounds in the narrow space between seat and cowl—and had

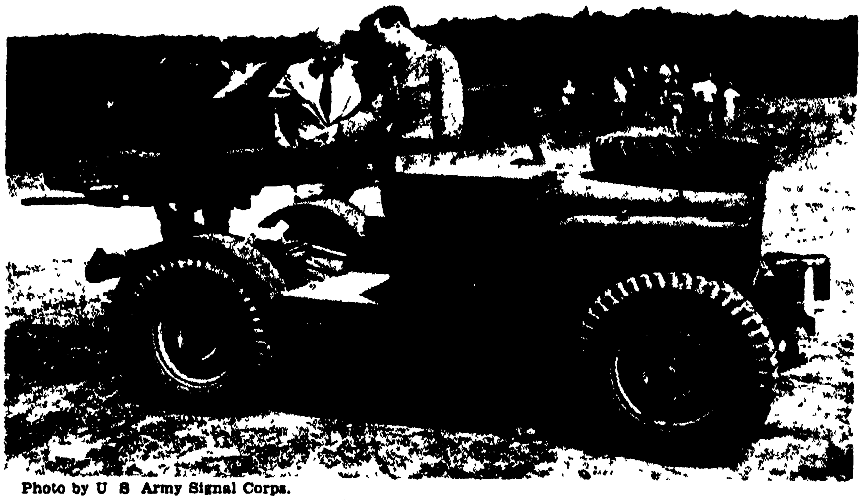


Photo by U S Army Signal Corps.

A 37 mm. anti-tank gun mounted on a jeep

lots of leg and arm room to spare!

"Plenty o' clearance," my driver remarked.

We crossed a small stream, water flowing over the floor. But we had no trouble, for electric units are placed so high that the 40-inch jeep can keep going through water 18 inches deep. We clawed our way up the 30-degree bank—twice as steep as you'll ever meet in a passenger car on the highway.

Rivers are an army's worst obstacle in enemy country, and raft or bridge builders offer splendid targets. It was enlightening, therefore, to see jeeps ferried across streams atop three rowboats, on rafts of empty oil cans, and on stray logs wired together. Latest plan is to lay a heavy tarpaulin on the ground, drive the bantam on it, fold up the sides, then drag it into the water where it will float with some support Tacticians call this simplicity, plus.

Back in camp, in the warehouse section, Lieutenant Summerour gave me one more thrill He drove the car up a narrow ramp to a railway loading platform, drove along the platform, steered through the open door of a boxcar, passed through the car to a ramp on the other side, and down to the street.

"Think we've got something here?" he asked, getting out of the bantam. I certainly did.

A heavier version of the jeep is the "swamp buggy," with bus-size tires for deep snow and mire. Most important, it's mounted anti-tank gun can be fired forward. It is not towed behind. This means quicker striking power.

In the Louisiana maneuvers, involving 400,000 troops, Army eyes were on its three new anti-tank battalions. All include jeeps and well-armed jeep-riding soldiers. Company A, of the 94th Anti-tank Battalion, for example, has 51 jeeps, some drawing anti-tank guns, others carrying ammunition

The jeep has helped mightily to lay the legend of tank invincibility Brigadier General Ira T. Wyche, commanding the 1st Provisional Anti-tank Group, says cheerfully: "We might retire if attacked by heavy opposing infantry, but never from a tank outfit." Already the jeep has made major changes in army concepts of cross-country mobility It also fits into the traditional American notion of individual action in war.

When war ends, jeeps can do useful work. An artillery officer told me they would aid certain kinds of farming which need practical "Model T Ford" type transportation. Or, with a few trimmings for looks and the spur of low gasoline consumption, the jeep might make good in cities. Lessons learned by jeep manufacturers surely will be put to practical use in improving your car and mine.

Editor's Note: In the nomenclature of our Armored Divisions—which has reached almost the stage of a special argot—the term "jeep" is used to designate the one and one-half ton command car, while the miniature combat car, so often pictured in mid-air, is known as the "peep"—sometimes, "the son of a jeep." This is according to advices from the Bureau of Public Relations of the War Department, which explains that in other branches of the Army, however, "jeep" and the various names mentioned in the above article refer to a bantam car.

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DECOY BLACKOUTS

Dummy Airfields, Deserted Roads, and Empty Areas

Dummy airfields with dimly shining lights, wide open spaces illuminated to simulate crowded areas, and long lines of glowing street lamps on deserted roads are now being studied as a means of literally camouflaging whole cities in event enemy bombers reach America's shores.

"Tragic ineffectiveness of London and Berlin to protect themselves from night raiders with total darkness is forcing the United States government and commercial lighting experts to seek startling new blackout techniques, many of them secret," according to Samuel G. Hibben, Westinghouse blackout lighting engineer.

Since there appears to be no way of preventing bombers from dumping their lethal loads over the centers of blacked-out cities, engineers are now studying means of inducing them by camouflage to aim their bombs where direct hits will cause little or no damage, Mr Hibben declares. He points out that in the camouflage version of the blackout, decoy airfields, highways and industrial centers could be changed for each raid. They would be located well out of the way of residential areas.

From the air, a string of partially concealed lights along a deserted stretch of road would appear to be a main artery leading into the city Actually it might point in an entirely different direction. Anti-aircraft and searchlight batteries located several miles from a metropolitan center would be just as effective but would tend to draw pilots away from vulnerable areas. A broad rectangle of flood lights anywhere would serve as airfield decoys. Americans who drive cars with sleek, black tops probably will be obliged to swab their autos with some dull, removable finish in event of air raids. Even moonlight reflection on the tops of closely parked cars offers an ideal target from the air.

Insanity

Paranoia; Dementia Praecox, or Schizophrenia; Paresis; Senile Dementia; Toxic Insanity

L. J. PANKOW, M.D., B.M., B.S.

PARANOIA was formerly believed to be a form of insanity in which the patient was insane on one subject only, and mentally normal on all other subjects. This is now known to be false, for the paranoid suffers from a general mental slowing and degeneration. The paranoid suffers from very definite and well systematized delusions. This definitely affects his judgment, especially in matters pertaining to his delusions. Paranoia usually follows a definite course of three stages. The condition may become arrested in any of the stages, and remain there for years. The stages may be reversed and the third stage may occur very early. The first stage usually begins in childhood, although it may not be recognized at that time. These patients are said to have been queer, taciturn, morose, avoiding other children and associating with older persons. The patient begins to feel that people are acting differently toward him. Older patients at this stage frequently complain that they fear they are losing their minds or their health This gradually progresses into the second stage, ushered in by delusions of persecution and corresponding hallucinations, especially of hearing.

Up to this time the subject has suspected that people were cold and aloof to him, but now he knows it, and hears them saying unpleasant things about him. The voices are very apt to become vulgar and terrible, accusing him of crimes and sins. Other hallucinations substantiate this belief. People are poisoning his food, are trying to gas him or to injure him with electricity. He builds elaborate defenses against these dangers, sealing up all doors and windows, or setting his bed in saucers of water as insulation. After a time he begins to recognize the individual who persecutes him and instead of they who are persecuting him, it becomes he.

When the patient changes his ideas from *them* to *him*, he becomes dangerous. At first he flees from his persecutors, then he defends himself, and, finally, he strikes in retaliation Having retained some of his mental faculties he is able to reason to some extent, and so is very dangerous This stage may last for years before giving way to the third stage, the stage of ideas of self-importance He begins to see that being such an object of persecution, he must be someone of great import. At this stage, the dual personalities or alterations of person appear. With this stage comes a more pronounced mental deterioration and enfeeblement even to an ultimate complete loss of mentality.

DEMENTIA praecox is a form of insanity in which there are delusions and hallucinations and various mental disorders. The mental deterioration shows to a marked degree early in the disease, and the delusions are much more fleeting and changeable. Usually, dementia praecox is seen in younger persons, but this is not invariably so. Recently, the name schizophrenia has been suggested. This means splitting of the psyche, and refers to the fact that in these cases there are frequently two or more trains of thought traveling together simultaneously.

In general, dementia praecox also has its beginning in childhood with some oddity being apparent. These patients usually have been dull, but may have been unusually bright. They are frequently shut-in types, having no one with whom they can talk over their problems. Some of the exciting factors of insanity come along and set them off into a recognizable psychosis. It is impossible to guess the subject's reactions and answers. A question may bring a totally unrelated answer, a command may bring an opposite action, or no action at all. All this is due to his twin or double train of thought This also accounts for the incoherence of speech found so regularly in these cases, and to the emotional deterioration There are three types of dementia praecox, but these types may overlap or combine to give apparently more types.

Pure dementia praecox, or hebephrenia, is one type. A very mild form is sometimes called the simplex type or abortive form. This is a stationary form in which the disease has not progressed far enough to be called real insanity, when it becomes halted. The patient is able to lead a more or less normal existence except that his personality is greatly changed. It is from this class that hoboes, prostitutes, cranks, eccentrics, and criminals develop

CATATONIA, or catatonic dementia praecox, a second type, has the usual onset and general symptom syndrome plus catatonia Catatonia is an irregular alternation of excitement and stupor. In stupor we find negativism and muscular tension. These may be mild or severe, varying from being scarcely noticeable to so severe that the patient lies perfectly quiet in bed, refusing to speak, ignoring the calls of nature, holding the saliva till it putrifies and responding, if at all, to a command by an opposite action A muscular rigidity resists all efforts to change the position of the body parts, and provides grotesque facial expressions held for long periods at a time. The condition may express itself in a waxy condition of the muscles and, while the limbs are easily moved by the examiner, they remain in the final position for long periods, dropping only from exhaustion. Catatonic excitement is just the opposite of the stupor, being shown in constant talking, tossing in bed, walking, and becoming maniacal. Talk has no goal, and is often completely incoherent. The patients are very impulsive, follow their impul-

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Originally published in *The Journal-Lancet*, Minneapolis, Minnesota The author, with a medical degree from the University of Minnesota, is a Sioux Falls, South Dakota, general practitioner who served on his county insanity board for 15 years, and the article is based on his studies and experiences during that time In a previous article in the December number, he discussed the general nature of insanity.

sions, and are unable to explain any reason for their violent acts.

The third form of dementia praecox is the paranoid form. This is a usual dementia praecox with considerable dementia and paranoid symptoms added. The paranoid symptoms differ from true paranoia in that the delusions are fleeting and changeable, and not well organized. They are usually persecutory in nature, but the type of persecution will vary from day to day. Such patients do not try to explain to their associates the reasonableness of their delusions as do the true paranoids.

A VERY frequent and most unhappy form of insanity is the manic - depressive, circular or cyclic insanity. The chief symptom of this disease is the recurrence of periodic phases of exaltation or mania alternated with phases of depression or melancholia. Usually accompanying these abnormal states are either corresponding or reversed expressions of motor activity. This means that a patient may be quite maniacal in his thoughts but quite normal or even subnormal in his physical activity, or the converse. Usually, however, the physical state corresponds to the mental state, the patient being agitated when in a mania and quiet when depressed. Some patients do not exhibit an alternation, but have cycles of mania or excitement only, and others have only cycles of melancholia, either being interspersed with apparently quite normal intervals. It is the recurrence of symptoms in a definite cycle that gives the disease the name of cyclic insanity.

The usual findings during a manic phase are a flight of ideas, emotional excitement and increased motor activity. Hallucinations and delusions may develop, and if they do, they are usually of a grandiose nature. The depression or melancholic phase is the exact opposite of the maniacal. It is characterized by difficulty of thinking, emotional depression and decreased motor activity. When normal or nearly so the patients have quite an insight into their condition, and will discuss it intelligently with their associates. This type of psychosis is explained on the basis that when excited the patient is trying to keep up with his problems and is, in his mind, doing so. When in a depression, the problems of adjustment have simply overwhelmed him with their multiplicity and magnitude.

The psychoses so far described are those in which there is no demonstrable physical change in the brain structure itself. They are pure psychoses, or alterations of thinking due to the inability of the patient to deal with the problems of environment and society. There are also insanities in which the mind would, perhaps, never have failed had it not been injured or diseased. Aside from actual injuries to the brain with actual loss of brain tissue, it may be due to scar formation, pressure atrophy of brain tissue due to tumors, abscess, meningitis, depressed skull fractures; or the injury may be the result of infection or toxin from within the body, or drugs. The manifestations are apt to vary, depending on the extent of the injury, the degree of toxicosis, the parts of the brain involved, and the thing causing the effect.

PARESIS is the first of this type of insanity to be discussed. It was a well defined disease entity long before it was learned that it is invariably caused by syphilis. Synonymous with the term paresis was the name "general paralysis of the insane," because it is more than just a psychosis Before death, the patient invariably develops quite typical motor as well as mental symptoms. While every case of paresis is syphilitic in origin, not every case of syphilis develops paresis, nor does every case of neuro-syphilis have paresis. Locomotor ataxia, for example, is syphilis of the nerves of the spine, but not always is it found in a combination with insanity, and when it is so found, it is referred to as tabo-paresis. Early in the course of paresis, the only symptoms noticeable are a gradual deterioration of the intelligence, defects of judgment, memory loss and evidences of moral delinquencies. These things constitute the first stage of the disease.

The second stage usually presents physical changes added to the mental changes noted before and in addition more pronounced mental defects. The physical things easily noted are muscular tremors especially of the muscles of speech. These cause a peculiar quality of tremulousness in speaking certain words and phrases. A progressive general muscular weakness follows. Frequently, the patient is subject to seizures similar to apoplexy or epilepsy, which usually last longer than an epileptic fit, and disappear more quickly than an apoplectic insult. They leave very little or no motor paralysis, but it is very likely that there will be a very marked mental deterioration noticed after the spell, and the patient does not recover from this mental paralysis. The new level of mentality becomes his normal plane, and a new seizure will sink the mentality to a new low level. Memory fails more and more as the disease progresses, and all the mental defects of the first stage become more pronounced. Delirium develops, emotions are lost, speech becomes difficult, but not yet entirely lost.

AT THIS point in the disease, paresis usually follows one of four types, and little more than mention of them should serve to differentiate them. They are: the demented, in which loss of mentality is the chief symptom; the excited, in which there is terrific mental activity with expansive and grandiose ideas; the agitated, in which there is a great deal of motor excitement and the patient must be constantly on the go; and the depressed, in which one finds symptoms similar to those found in the depressed phase of a cyclic insanity, but with no alternation of the phases. It is usual that paretics are discovered in one of these four types of the second stage of their disease.

The third stage is the final curtain for the paretic. It is the final, eventual and complete breakdown of the mentality. The patient ceases to have any human reactions whatever, and exists like a vegetable, totally unable to care for himself in any manner, losing control of his sphincters, soiling himself and finally being unable even to feed himself. These things constitute the major and most easily recognized symptoms of paresis. The most constant and dependable are the speech difficulties and the positive Wassermann reaction in an insane person.

The senile dementias have one thing in common that allows grouping them together. That thing is that changes incident to age so lower the threshold of mental balance that complexes and conditions which have been previously handled or compensated satisfactorily, are now allowed to come to the surface, and so manifest themselves as psychoses. Involutional melancholias, various delusions, anxieties, and true senile dementias, with incident memory and judgment failures, egotism and paranoid ideas are examples of this condition. Arterio-sclerotic dementias are probably expressions similar to these, with the added insult of brain starvation and actual loss due to atrophy. To an appreciable extent, the psychosis will be manifested by and dependent upon the area of the brain altered by the sclerosis. One almost constant finding in all cases is an increasing forgetfulness for recent affairs and events, faces, names and places. This obtains in the arteriosclerotic types, chiefly, and accounts for the frequency with which this type gets lost when a very short distance from home, and indeed, even within the home itself.

The last group comprises the infection, exhaustion and toxic types of insanity. These, in addition to the deliria, may simulate more or less any of the types discussed before; but, in general, when the disease has been cured, the infection removed, the toxin eliminated, or the exhaustion corrected, the psychosis improves. It is just that the patient has a low threshold, and the waste products that have accumulated have weakened the defenses of the mentality, allowing some of the problems that have been compensated to decompensate. The patient gets out of adjustment with his environment until the body balance has been restored. Any of the symptoms expected in almost any of the other insanities mentioned may be found as well as some manifestations which are new and strange.

In conclusion, only the high-spots of the symptoms and signs of the common types of insanity have been discussed. There is, however, one thought which should be emphasized: The inability of persons to adjust themselves satisfactorily to their environments and problems, introduces a big field in preventive psychotherapy. Just as a weak rope will break when overloaded, so a mind breaks when it tries to carry a load too heavy for itself. Poorly adjusted individuals and those whose minds can be likened to weak ropes, should be helped to make a proper or a satisfactory adjustment, not by demanding more from them than they can carry mentally, but by finding for them a field of endeavor where the problems will not be more severe and heavy than they can carry.

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IMPAIRED SIGHT

Induced by Insulin Offset by Oxygen

Administration of doses of 100 percent oxygen will offset the impaired sight induced by insulin, according to Dr. Ernst Gellhorn, professor of physiology at the University of Illinois. This sight impairment takes place, he points out, as a result of the close relation between oxygen and blood sugar content. Administration of insulin in "shock" therapy, for example, decreases excess sugar in the blood, deprives the brain of some of the sugar which it burns, and thus produces visual disturbances including loss of the ability to see "after images."

"It was found," Dr. Gellhorn says, "that the effect of low blood sugar induced by insulin was alleviated by inhalation of 100 percent oxygen."

ASYLUMS

Some Mental Hospitals Are a "Disgrace"

"Some mental hospitals are a disgrace!" This serious charge is made by the National Committee for Mental Hygiene in its annual report, just published.

A recent nation-wide survey conducted by the Committee reveals, the report states, a "dismal failure of state authorities in many parts of the country to provide adequately for the mentally ill.

"The depression has put in its deadly work, and standards of care in many institutions have fallen far below the requirements of modern psychiatric practice—in some places to such a point as to suggest a reversion to the conditions of the old asylum era."

Institutions in all parts of the nation are excessively crowded, the survey revealed. This is considered due partly to the fact that the average length of life has been extended 13 years in the last 40 years. Mental disease affects more individuals proportionately among old people than in the younger age groups. One person out of 20, it is estimated, will become a patient in a mental hospital some time during his lifetime.

In probably 12 or 13 states, the superintendent of a state hospital is a political appointee. He may be chosen, not because of his knowledge of mental illness, but because his cousin carried three districts in the south of the state. And he is subject to instant dismissal whenever the political regime changes. This condition makes the whole staff of the hospital, even when they are thoroughly competent professionally, feel insecure. The best men are apt to leave such a hospital and go into other work or to another state.

ATHLETE'S FOOT

Infection Reduced by New Flooring

The danger of acquiring athlete's foot and warts on the soles of the feet from swimming pool runways, locker and shower rooms may be reduced by use of a copper cement flooring material called Hubbellite, Dr. W. L. Mallmann, of Michigan State College, reports in the *Journal of the American Medical Association*, according to *Science Service*.

When the fungus that causes athlete's foot was spread on blocks of glass plate, ordinary cement, and Hubbellite, Dr. Mallmann reports, the fungi multiplied on the glass plate and ordinary cement to double and triple the original number after four and eight hours. On the Hubbellite the fungi were reduced from 72,000 to 74 after eight hours.

Hubbellite was developed by D. S. Hubbell at the Mellon Institute for Industrial Research at Pittsburgh. It is said to owe its germ-killing property to the minute amounts of a copper compound which are released from the flooring when it is wet. It was effective not only when wet with water but when milk was smeared over it, Dr. Mallmann found, suggesting its usefulness on the floors of dairies and kitchens to help keep down germs.

Malodorous Mercaptans

Removal of Sulfur Compounds From Gasoline Gives Greater Susceptibility to Ethyl Fluid

H. W. FIELD

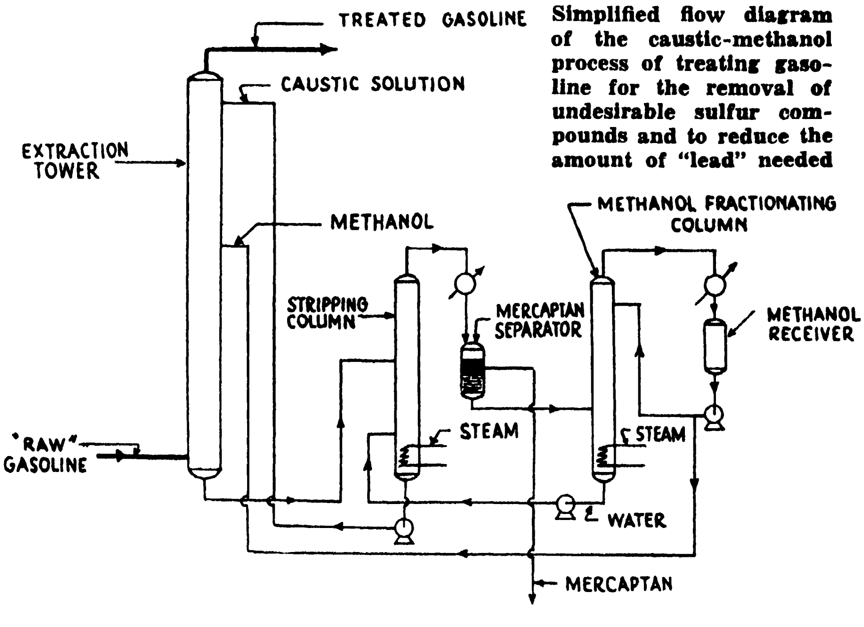
INDUSTRIAL pioneering in the petroleum field has led to the development of a new method of purifying "raw" gasoline and rendering it more susceptible to treatment to improve its anti-knock qualities. Raw, or unfinished, gasoline, as produced from crude petroleum, either by straight distillation or by the cracking process, contains malodorous compounds known to the chemist as mercaptans. These mercaptans are chemical compounds of sulfur, and are usually found in crude oil; they have such an obnoxious odor that practically all refiners have, in the past, resorted to treating operations involving the use of lead oxide and caustic soda—the so-called "Doctor Treating"—which converts these mercaptans to relatively odorless substances, hydrocarbon disulfides. This treating procedure was expensive; moreover, the mercaptans were simply converted into other sulfur compounds. The objectionable substances were not removed. Furthermore, both the mercaptans and the products into which they are converted have been known for several years to have a deleterious effect on the anti-knock value of gasoline and to interfere to a serious extent with the beneficial effect of substances such as tetraethyl lead, which are added to gasoline to improve its anti-knock value

In spite of the rapid and widespread "face lifting" which has taken place in refinery processing methods in the last decade, the naptha-treating plant has undergone little basic change by the onslaught of new technique and, in many plants, stands as an expensive citadel which successfully has resisted all development efforts. It is true that various schemes of regenerative washing have eased the treating-cost burden in many places, but these have been only partial answers to the problem: mercaptan conversion, by doctor treating or otherwise, continues today to be the predominating means of improving gasoline odor, despite the fact that the processing methods are harmful both to a fuel's octane value and its susceptibility to tetraethyl lead treatment.

THESE deleterious effects have been known for several years. Naturally, the obvious answer to the problem has been the removal of the mercaptans. That much was easy, but how to do it was something else again. Petroleum research engineers have been attacking the problem for some years. In the first place, the mercaptans in the heavier parts of gasoline have objectionable odors, but are not sufficiently soluble in a cheap reagent, such as a solution of caustic soda in water. Moreover, organic solvents, such as the alcohols either alone or in caustic-soda solution, are excessively expensive, particularly if appreciable quantities are lost in the treated naptha. Further, any solvent which removes mercaptans, will, of necessity, gradually become fouled with other substances in the gasoline, such as sulfides, sulfates, thiosulfates, phenols, thiophenols, fatty acids, and so on, unless some mechanism is provided for discharging these materials from the recirculation system without incurring excessive cost in the loss of solutions.

This looked like a large order to expect any process to fill. Fortunately, gasoline is a large-volume product of the petroleum refinery, and if a way could be found to bring about fractional savings in tetraethyl lead and octane level, these savings in the course of a year would build up into large dollar returns. This furnished the incentive for much extensive research and development work and eventually resulted in the development of the caustic-methanol process, by research engineers of The Atlantic Refining Company. This new process meets the requirements imposed by the mercaptan-removal problem in an unusually satisfactory manner and, in addition, the commercialization of the process has disclosed that the unit manufacturing costs are considerably lower than had been anticipated at the beginning of the development This fact increases the economic incentive for the installation of the process, and, as a result, large plant installations are now being designed.

Research in the development of the process involved almost endless studies of gasolines, the mercaptans, and other substances which contaminate motor fuels, both alone and in mixture with various strength solutions of caustic soda in water. Before the process could be perfected, the investigation was extended to include balancing the costs of the solvents which were

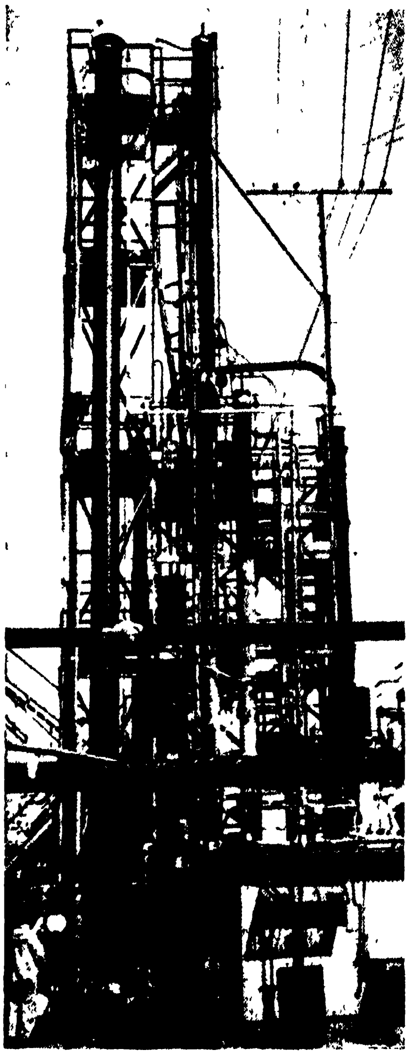


Simplified flow diagram of the caustic-methanol process of treating gasoline for the removal of undesirable sulfur compounds and to reduce the amount of "lead" needed

studied, ways and means to minimize losses in treated gasolines, the high solubility of the mercaptans, the ease with which the solvents used could be separated, and the overall flexibility of the process in treating a wide variety of raw gasolines.

Eventually, as a result of these studies, the researchers hit upon a single solution which was found to be most effective in treating the raw gasoline. It is a mixture of a solution of caustic soda in water, with methanol, or methyl alcohol. The combined solvent was found to be so effective that a substantially complete removal of the offensive mercaptans was obtained by recirculating in the plant an amount of "dry-cleaning" solvent which was less than 3 percent of the volume of the gasoline treated

As soon as the research work was completed, the process was put into practical operation in a semi-commercial plant having a treating capacity up to 15,000 gallons per day The operation of this plant is illustrated in simplified flow diagram in the accompanying drawing.


Semi-commercial treating plant

Raw gasoline is pumped into the base of the extraction tower at the left and flows upward. The methanol is introduced at the middle of the tower and flows along with the gasoline. The caustic soda is pumped in at the top of the tower. The combined solvents extract the objectionable mercaptans from the gasoline. The caustic soda solution, flowing down through the upper section of the tower, also removes practically all the methanol from the purified gasoline and settles at the bottom of the tower

The "spent" solution is then pumped from the bottom of the extraction tower to a steam-stripping tower. This includes an internal steam distillation apparatus, which distills off the methanol, the mercaptans, and some steam, thus cleaning the caustic solution so it can be used again. This is withdrawn from the bottom of the stripping tower and returned to the top of the extraction tower.

The distillate from the stripper is condensed, and the condensate separates into two layers in the receiver. The mercaptans collect in the upper layer, and are withdrawn from the system, and sent to the power house to be burned as fuel. The lower layer is a water and methanol mixture kept relatively free of mercaptans by controlling the water-methanol ratio at a point where the mercaptans are least soluble.

The water-methanol mixture drawn from the bottom of the separator is then charged into a fractional distillation apparatus. The methanol passes over and is returned to the middle section of the extraction tower. The water which is left is pumped to the caustic stripper. One of the photographs gives a general idea of the size and scale of the semi-commercial plant used for the development work.

An outstanding feature of the caustic-methanol process is the separation of the two components of the solvent and the return of the two separately to the extraction tower. The charging of the caustic soda solution to the top of the extraction tower causes this section to function admirably in the recovery of methanol. As a result, the loss of the expensive methanol is negligible.

Close-up of the extraction tower

Another important advantage of the separation of the two solvents during their regeneration for use again in the "dry-cleaning" process is the ability to control other contaminating substances which creep into the solvents. This is accomplished by bleeding out small quantities of caustic soda solution from the bottom of the stripper tower so as to control the quantities of the substances which tend to build up and foul the solvent. Extensive operation of the present plant has shown that no foreign materials build up in the methanol. As a result, it can be used indefinitely.

It was also found as a result of the study of a number of solvents that any solution capable of extracting mercaptans also will extract, to some degree, any phenols which occur naturally in gasolines. Since these substances usually are good stabilizers in controlling the tendency of gasoline to oxidize, their removal is not always desirable.

The caustic-methanol process offers considerable flexibility in handling gasolines of varying phenol contents. It will be recalled that, in the regeneration step, the methanol and mercaptans are distilled from the caustic-soda solution. This regenerated caustic solution contains phenols and other acidic components extracted from the gasoline. If the stability characteristics of the gasoline being treated are such that the final product will be better because substantially all of the acidic bodies have been removed and because a synthetic inhibitor is used, the process can be controlled accordingly. This is accomplished by discarding a caustic solution when it becomes rich in phenols (50 percent by weight). The high ratio of phenol to caustic in this type of operation results in a low consumption of caustic soda.

If, on the other hand, the nature of the gasoline being treated permits the advantageous retention of the phenols, the process can be controlled to favor this retention. This is accomplished by permitting the phenols to build up in the recycled caustic-soda solution. The carrying power of the reagent for mercaptans is not impaired by this, but the extraction of phenols from the gasoline is substantially reduced.

The use of the caustic-methanol process results in a considerable improvement in the anti-knock value of the treated gasolines. In the older processes where the mercaptans are converted to other substances which remain in the gasoline, the octane values drop as much as 0.25 to 1.0 numbers. With the new method the octane numbers of the treated products are equal to or better than those of the raw gasoline. Furthermore, the treated gasoline is greatly more susceptible to treatment with tetraethyl lead to increase its anti-knock value, offering an attractive saving in ethyl fluid in all cases. This is highly important today, with lead shortages staring industry in the face.

EDITOR'S NOTE: While there are other means of achieving mercaptan removal from gasoline than that described in the foregoing article, the details of the Atlantic process are published because of the economic significance of the whole general problem. Further, the process described has advantages of low installation and operation costs, the latter largely through the use of solutions which can be regenerated and used indefinitely with little loss.

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PLASTICS PRIORITIES

Made Necessary Where Methanol is Needed

ALUMINUM, steel, zinc, copper, bronze, and so forth, and now plastics, have been placed on the priorities list—in particular those plastics which require formaldehyde or derivatives of methanol in their manufacture.

Formaldehyde comes from methanol. Methanol is secured in two ways—one, by the distillation of hardwood; two, from synthesis of carbon monoxide and hydrogen. It is from this latter source, synthetic methanol, that most formaldehyde used today in plastics is secured. It so happens that ammonia may also be made from methanol. Ammonia is valuable in the manufacture of explosives and many formaldehyde producers have necessarily had to change to ammonia production. In addition, it is said that methanol itself may now be used in making a super explosive. Consequently the market in formaldehyde is tight and this material is high up in the priorities list. To overcome this condition, new ammonia plants are being built and it is expected that within a short time the production of formaldehyde may return to a more normal status.—*Durez Plastic News.*

REPLACEMENTS

Developed in the Radio Manufacturing Field

AS A result of the search for alternate materials in radio sets, RCA Laboratories has developed more than 40 replacement materials; one item alone has saved 148,000 pounds of aluminum in the plants of the RCA Manufacturing Company.

Aluminum was one of the first items, essential to the radio industry, affected by priorities control. In every RCA Victor radio set, aluminum cans were employed to protect intermediate transformer coils. Four millions of these cans had been used in 1940; therefore, if they could be replaced by using an alternate, a tremendous saving in aluminum would result.

A fabricated cardboard tube, coated with a moisture-resisting substance and a sheet of copper foil, was tried instead of the aluminum can; marked success was achieved. The aluminum thus saved has so far amounted to 74 tons. Another important saving of aluminum was effected by using a plastic in the record changer control segment of radio-phonographs.

Plastics are under consideration to replace the metal housing that protects loudspeaker cones in radio receivers. They can also be used in making dial faces and a number of other parts in both radio and phonograph equipment. Their possible field of application is extremely wide But even plastics are meeting curtailment.

Thereupon, the job of finding an alternate for an alternate was started. The answer was a felted substance made from shredded wood, cardboard paper scraps, and sulfite pulp. Moulded into required forms and treated with a moisture-resisting impregnant, it proved to be as tough as either wood or plastic. It can be covered with fabricoid or other surfacing. By the use of thermofusion, metals can be bonded to it. Perfection of this substance opens up new avenues of manufacturing development.

MOVIE TRAINING

Now Available For Lathe Operators

TO SPEED up the training of lathe operators, the South Bend Lathe Works has sponsored the production of a series of 16mm sound motion pictures in full color based on the book "How to Run a Lathe." Professionally filmed by Burton Holmes Films, Inc., at the South Bend Lathe Factory, these pictures show practical shop methods as practiced in modern industrial plants. Showing time for each of the two 800-foot reels now completed is approximately 20 minutes.

The first reel, entitled "The Lathe," clearly shows the apprentice what a lathe is, what a lathe is for, and how the various parts operate. Important lathe operations, including turning, facing, and thread cutting, are demonstrated. The second reel, "Plain Turning," shows in detail each operation performed in the machining of a straight cylindrical shaft between the lathe centers. Close-ups show locating and drilling of center holes, adjustment and setting of cutting tools, use of cross-feed graduations, use of calipers and micrometers, use of quick-change gear box, changing speeds, and operation of the lathe carriage and apron.

Factory apprentice schools, vocational schools, Army and Navy training schools, colleges and high schools teaching machine shop practice will find these films helpful in training lathe operators. Complete information on securing the use of these films can be had by writing to South Bend Lathe Works, Dept. S7, South Bend, Indiana

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EYES—In round figures, eye accidents cost American industry at least $50,000,000 annually in lost time, medical expenses, and compensation. The average cost for an industrial eye injury is $343, as compared with $194 for all other types of occupational accidents.

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TRANSPARENT

Glass Building Block Provides Vision

A TRANSPARENT glass building block that affords almost window-like vision has been developed by the Pittsburgh Corning Corporation, a jointly owned subsidiary of the Pittsburgh Plate Glass Company and the Corning Glass Works.

The new block, called the "Vue' glass block, was developed for specific needs where some outside vision is desired through panels of non-transparent glass blocks. The new block permits sufficient general vision of large objects or movements beyond the panel to prevent a "shut-in" feeling, although the visibility of sharp detail is not possible under most conditions. The Vue block combines the high insulation properties of the usual glass block; it contains a partial vacuum, a dead air space, which results in the glass block panel having approximately the same insulation value as a solid masonry wall eight inches thick, and more than twice the insulation value of ordinary single-glazed windows.

In factories where non-transparent blocks have been used in exterior walls, a common custom has been to install several rows of transparent window glass panes. Several courses of Vue blocks might very well be combined with a selected conventional glass block pattern to achieve approximately the same light transmission and visional properties, but with the added advantage of better insulation.

New block provides vision panel

In certain instances, workmen in factories where all light-transmitting areas are of obscure glass, or where plants are windowless, have indicated a mild feeling of claustrophobia This shut-in feeling could be alleviated by the use of a few of the new blocks inserted in the center of the large glass block areas to provide a vision panel

ROSIN

Increased Production and Use of Derivatives

ROSIN derivatives, now used in lacquers and paints, plastics, roofing, floor tile, and the box toes of men's and women's shoes—many of these being entirely new uses—are to be produced in large quantities in a new plant of the Hercules Powder Company, now in operation in Hattiesburg, Mississippi.

The new plant will use molten rosin delivered to it by pipeline from the adjoining Hercules naval stores plant, eliminating the packing, cooling, shipping, and remelting normally required in handling rosin. Another reason for locating the plant at Hattiesburg is that large supplies of hydrogen, used in the manufacture of the chemicals, can be obtained from natural gas available in the Louisiana and Mississippi oil fields.

"The series of rosin esters which this plant will produce will help diversify the rosin producer's market," a company report states, "for substantial quantities of these esters are already used by industries which have never used rosins before. An industry sending its products into many varied industries where they serve a multitude of purposes can only gain from technological progress. In fact, by furthering chemical research, it can both serve industrial needs and benefit by the greater use for its own products. This purpose has motivated the Hercules program of fundamental research on rosin derivatives."

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CHAINED: Defense workers are being chained to machines by the wrist—but as a safety measure. The wrist device, called the Posson guard, uses a pull cord attached to the machine which prevents the worker from getting his hands or arms into the mechanism when it is in operation.

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INDUSTRIAL AID

Supplied by Available Chemical Engineers

AN INCREASING number of manufacturers are finding it impossible to secure certain raw materials for the operation of civilian supply industries, and are attempting to turn to the production of usable merchandise made from raw materials that are not subject to priorities. In many such cases, however, technical problems arise which the manufacturers are unable to solve with available facilities. To meet this crisis these manufacturers have to avail themselves of independent consulting chemists and chemical engineers, often difficult to locate.

Manufacturers who find themselves in this predicament will be referred to an association where they can obtain free listings of consultants for such chemical problems, if they will address the Editor of Scientific American, stating their needs briefly.

INDUSTRIAL TRENDS

INDUSTRY LEARNS FROM DEFENSE

MANY of the lessons that American industry is learning under the forced draft of national defense production are going to have a very definite effect on the general trends of all industries in the immediate future as well as in the time of peace which will ensue. Any consideration of these lessons cannot stray far from the automobile and aviation fields, since it is in these industries that the greatest effort is being made to press production to the limit in providing the means for transporting huge numbers of men and vast quantities of materiel for military purposes. But, although consideration centers in these two closely linked industries, implications of developments accomplished and still in the formative stage are spreading and will continue to spread into all industries however remote from the centers of automotive production.

Outstanding example of technological progress in aircraft engine building, fostered by the laboratories of the automobile industry, is the production of cylinders from castings instead of forgings. When time was of little moment in airplane engine construction, the individual cylinders were machined from large forgings often weighing up to 100 pounds, for the production of a unit that, finished, would weigh only 15 pounds or so. Here was tremendous lost motion, lost time, inefficient use of material. Then came the contribution of centrifugal casting, by which were produced cylinder castings weighing only about 20 pounds and which needed only a minimum of machining to produce finished units. Time, material, machines, and manpower needed for the job were reduced, production was stepped up.

One word in the preceding paragraph holds the key to the success of cast cylinders—"centrifugal." Automobile engines have, of course, been made almost universally with cast cylinder blocks. But in a motor-car engine, low weight is of little consequence; in an aircraft engine it is essential that weight per horsepower be kept to the lowest minimum. Castings made by conventional processes cannot be machined to thin sections; to do so results in reduced strength. Thin sections in cylinders are required in aircraft engines to reduce weight; hence the use of forgings in the past. Automobile engineers, however, always unconventional, developed the centrifugal casting method to a point where it could produce cylinder units sufficiently strong to be machined to thin sections, and the problem was solved.

Obviously this casting method, which spells success for high-speed production of aircraft engines, will not be confined to the automotive field. There are many places in industry where it will find wide use in many applications, replacing forgings in some cases, developing new products in others. Together with powder metallurgy, this latest trend in the development of methods of producing a variety of shapes from metal will undoubtedly take a place of outstanding importance in the industrial world.

Another example of the effect which the automobile industry is having on the production of airplanes is to be found in the efficient utilization of multiple drill units for high-speed work. Where many hours were formerly spent in drilling holes in the main framework of a certain engine, the time required has been reduced to a few minutes more than one hour. Again, a number of machines labored for an hour to drill the required holes in an engine cylinder; time required on the job after automobile engineers tackled the problem was only three minutes—and this was accomplished with a smaller number of machines than was formerly used.

It stands to reason that these lessons of efficient machine utilization, just as in the case of centrifugal casting, are not going to be confined to any one or two industries. Engineers are finding that methods peculiar to one type of work can often be applied to other fields with equal success. And under present stimulus these applications are being ferreted out and developed to the benefit of all.

From what has been said above it must not be assumed that this automobile-airplane co-operation is all one sided. While motor-car engineers are contributing mightily to speeding-up aircraft production, they are also, in turn, learning lessons from the technicians of the aircraft industry. High-octane fuels, long used in airplanes, require special engine design of the sort that is meat for the aircraft men, automobile technicians are devouring the details of these designs and it is no shot in the dark to state that, beyond doubt, high-octane fuel will be used in the motor-cars of the future, with engines that will utilize it efficiently.

Then there are the techniques of using light-weight materials, special alloys, high-strength construction, and so on which have been brought to a fine point of perfection in aircraft work and can be applied to automobile design with decided advantages.

Such facts as have been set forth in the limited space available here give strength to the statement that there is certainly a bright industrial side to the grim business of preparing for national defense, the lessons learned by industry as a whole are leading rapidly toward more efficient use of available materials and the development of alternate materials to bolster or replace those of our natural resources which are limited in quantity or more urgently needed for other purposes.

SYNTHETICS NOT ALWAYS SUBSTITUTES

NOT all research in synthetic-rubber is being directed toward replacement of the natural product. In fact, many uses for materials that are emerging in a steady stream from the synthetic-rubber laboratories are being found where rubber had never been considered before. Thus a new non-metallic synthetic has been produced by the United States Rubber Company that is only one third as heavy as aluminum and will release much of that metal for other purposes. Upon impact of bullet or shell, it resists shattering, it does not fatigue as do some metals when subjected to vibration, it does not corrode. All these qualities point toward a promising future for this synthetic, so far known only as C-102. Industry will be quick to find use for a material of this kind.

—*The Editors*

OUR Point OF VIEW

TELESCOPTICAL CANFIELD

Elsewhere in this number is the first part of an article by the scientist in immediate charge of the 200-inch telescope mirror being built in California. Nowhere does he answer the one question which everyone asks: "When will the mirror be finished?"

A probable reason for this omission is that he doesn't know, and a still more categorical answer is that, literally, nobody does. Yet no inquirer—at least no real American United States Yankee—has ever accepted this answer lying down All inquirers, when told that nobody knows, come straight back with something like: "But when?" Or, "If you don't, where can I find out?" Or, "When do they think it will be finished?" It is as if they suspected one knew all along, and determined that they would somehow mine it out of you.

It isn't the "grinding"—to use a term by which those who have never tried the work usually designate the whole process. It isn't even in the polishing that follows the grinding. It is the final operation called figuring, and which involves alterations seldom deeper than hundred thousandths of an inch and usually only millionths of an inch, that contains the real grief, the big headache.

Short of accidents, the concavity can be roughed out with coarse abrasive grains and smoothed to the satiny finish of fine-ground glass with finer and finer grains, working to a predictable time schedule. Polishing with rouge is similar in this respect

In the next and final stage comes work that is art, not mechanics alone. Here and there millionths of an inch of glass thickness must be shaved off with local tools. Here predictability ends. Too much may be shaved off. Or some may be shaved off in the wrong place The work must then be done over again. Often this going back is repeated over and over again. The object of the game is to do it times enough so that, ultimately, all the parts of the mirror's surface will come out right at the same time, with no areas too high or too low.

Seeking for a comparison that will "register" with the reader who never has tried this game even on a small mirror (where the principles are much the same) the game of Canfield comes to mind. You get almost through and find you can't come out. Start all over again. Maybe do this several times. This sort of thing largely gives the answer to the question, "Why can't they say when the mirror will be done." It's a game. A month? A year? Longer?—*A G.I.*

RESEARCH AND LABOR

Great as have been the contributions of research—both pure and applied—to industrial development, there still appears to be wide-spread misunderstanding about the ultimate aims of the research laboratory. This is particularly true in the case of labor, where failure to appreciate the value of research results in a feeling of antagonism that frequently takes somewhat this form: "Those guys in the laboratory have it pretty soft. All they do is play around all day and draw good money. Me, I work like a dog and hardly get enough to live."

All of which goes back to the age-old battle between labor and so-called labor-saving machinery. For generations every mechanical development that resulted in apparent labor replacement has been bitterly opposed by just that group of workers which eventually reaped the greatest benefits. And the research laboratory of today is the birthplace of the fundamentals that are to become the mechanical improvements of tomorrow which, in turn, will benefit directly the man in the shop who may now be grumbling about "the guys in the laboratory."

As is perfectly obvious to anyone who follows even casually the course of science and industry, work in any sort of research laboratory cannot follow the well-defined lines of, for example, production operations on lathes or punch presses; on paper-making machines or in steel mills. The industrial workers have a carefully planned system of production that is followed throughout the working day; the laboratory technician conducting research is doing just what the name implies—searching for something, and that search, to the uninitiated, may very well appear to be aimless play. Hence there is a perfectly valid reason—in his own eyes—why the laborer should hold the research scientist in scorn.

Knowing full well that this state of affairs exists, it is indeed refreshing to hear of a representative of labor who has sufficient knowledge of the industrial world, and the right sort of intestinal fortitude, to make the following statement:

"The wages that workers in the pulp and paper industry now earn could not have been paid 25 or 30 years ago, no matter how strong the unions might have been, what their form of organization might have been (craft or industrial), or what labor legislation might have existed on the statute books.

"The pulp and paper industry is able to pay higher wages today because of improved methods of production which enable the mills to produce more paper at less cost than ever before. The contributions of enlightened management, engineers, technicians, and chemists in developing this great industry must not be overlooked or minimized as a factor responsible for the higher standard of living that the pulp and paper workers now enjoy." This quotation is from John P. Burke, president-secretary of the International Brotherhood of Pulp, Sulphite, and Paper Mill Workers.

Management, engineers, technicians, chemists—a complete research team: Labor receiving its share of the results of increased production and efficiency. Which is the way it happens in real life, despite any appearance of "play" on the part of the research worker.—*A.P.P.*

Molecular Spectra

More Complicated than the Spectra of Atoms, They Also Tell us More

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

SEVERAL interesting recent papers, dealing with the composition of bodies of astronomical interest, have this in common: they depend upon observations of molecular spectra

Molecules are quite as capable as isolated atoms of emitting or absorbing spectra. These spectra are more complicated than those produced by atoms, but for that very reason, when they are well understood, they give us more information.

The lines of a given atom—such as iron—are usually scattered along the spectrum with apparent irregularity, though intricate and accurate relations between their positions are revealed by thorough analysis. But in a typical molecular spectrum, the very numerous lines are obviously arranged in groups. At certain places they crowd together so closely that spectroscopes of the highest power are required to separate them. On one side of such a "band head" the lines are sparse, while on the other they are numerous, gradually increasing in separation and growing fainter, and forming a "tail." Head and tail are parts of the same structure—the head being the region where the lines are most closely crowded. With spectroscopes of low power, the separate lines are not resolved and the band appears continuous, shading away gradually from a sharp edge on one side. Often the head of a second band is superposed on the tail of a first, and so on, producing very complicated patterns.

What happens in a molecule when such a spectrum is emitted, is now well understood. But, even in the simplest case of a molecule composed of only two atoms, the possibilities are much more varied than for a single atom. In the latter case, an electron can be shifted from its normal state in the atom to another state, or fall back again, with absorption or emission of radiation of a definite wavelength—a spectral line. There are many kinds of these electron-jumps, and so many lines in the spectrum. The same thing can happen in a molecule, but other things may, too. The two atoms (more precisely their heavy nuclei) will, in the normal state of the molecule, rest in stable equilibrium at a certain distance apart. If farther apart, they attract one another; if they are closer, they repel one another. Hence, if they are disturbed from the standard position, they will oscillate about it with distance alternately less and greater Moreover, the molecule as a whole, whether the atoms are at their standard distance or oscillating, may be rotating about its center of gravity.

THESE motions, like all others that occur in structures of atomic dimensions, are governed by the quantum laws. There are a series of possible states of vibration which may be numbered 0, 1, 2, 3 . . . with amplitude increasing from each to the next, and a similar series of permitted states of rotation at increasing rates—usually very numerous.

The molecule can change from one to another of these states—according to certain rules. For example, the quantum-number defining the rotation changes by one unit. An electron-jump, a change in oscillation, and a change in rotation can all occur at once. No wonder the spectra are complicated! Changes in the rotation alone (which involve very little change in energy) give radiations in the remote infra-red. Changes in oscillation and rotation together usually produce bands in the nearer infra-red, and an electron-jump is usually required to get a big enough energy change to put the bands in the visible region.

With the same electron-jump and vibration-change, different changes in rotation (as for 0 to 1, 1 to 2, 2 to 3, and so on) produce lines very close together, the separate members of a band. A different change in vibration-numbers gives another band. The bands corresponding to such changes as 0 to 0, 1 to 1, 2 to 2, are often so close together that they tread on each others' tails, while 0 to 1, 1 to 2, and similar changes give another band-group, and so on. Thus we get a complicated band-system, which may fill a long range of the spectrum with thousands of lines, all from the same electron-jump. Another jump gives a different system of bands; —and finally, if the molecule is ionized, an entirely different set of systems of bands will result. Molecules containing three or more atoms give still more complex spectra.

BAND-SPECTRA are peculiarly characteristic of comets. The gases which form the head and tail escape from the solid particles of the nucleus and are set shining by absorption of energy from sunlight. The molecules C_2, CN, CH, CO^+, and N_2^+ have been recognized for many years. All five of them are fragments of the stabler molecules ordinarily known in the laboratory—the last two having lost an electron. Why the more familiar molecules do not show up is simple—their strong bands lie in the far ultra-violet, to which the Earth's atmosphere is opaque. We know, too, why the observed bands appear. They are all "resonance bands." A molecule of C_2, for example, in its normal state can absorb some line from sunlight, and become loaded with energy. Returning to normal, it emits this energy as light of the same wavelength. Other molecules, at the same moment, are working on other lines; so when we see the comet against a dark background, all the lines of the system appear bright. Once returned to the ground-state, the molecule can absorb again. Hence a relatively small number of molecules working steadily will give off a considerable amount of light.

Cunningham's Comet of last autumn, though not of the first rank, was bright enough to be observable with fairly high dispersion, and a long series of spectrograms were obtained by Swings, Elvey, and Babcock at the McDonald Observatory. These extend much farther toward the ultra-violet than any earlier observations, and thus reveal the presence of two more molecules, OH and NH, with bands near 3100 and 3360 angstroms. Like the others, these are fragmentary molecules, and the bands are resonance bands. From chemical considerations, we might expect these molecules to be present, since others containing hydrogen, oxygen, and nitrogen are. The strength of the bands indicates that they are abundant.

The cyanogen bands are extensively developed. Comparison of these bands with those produced in emission in the arc, or in absorption in the Sun, shows that the lines corresponding to the more slowly rotating states of the molecule are strong, while those produced by the rapidly rotating states are weak, or absent. That is, the average rate of rotation of a cyanogen molecule in the comet is very much smaller than in the arc or the Sun. The same is true of NH, OH, and CH.

In a gas of ordinary density, where the molecules collide with one another, very often the energy of rotation (of a diatomic molecule) will average two thirds as great as that of its forward motion, so that, at high temperatures, the high rotational states will be well populated. In a cool gas the slowly rotating states will be favored.

The density in a comet, even in the head, is so low that practically no collisions between molecules occur, but we can still speak of a "rotation temperature," such that in a gas of ordinary density the average rotation of the molecules would have the known value. The cyanogen bands in this comet show a preference for the rotational states which correspond to a temperature of 300 degrees absolute (about room temperature), and also a second group of lines indicating a slower rotation, such as would be found at 50 degrees absolute—much colder than liquid air.

If the density were not so excessively low, it would be impossible for two groups of molecules rotating at such different average rates to remain distinct. As things are, the observers suggest that the molecules of CN may be produced by two different processes of dissociation of parent molecules (such as would originally escape from the solid particles of the head), and that one of these processes sets them in more rapid rotation than the other.

If these molecules were left entirely to themselves, their rotation would slow down to almost nothing; for a transition from one state of pure rotation to a slower one, with emission of radiation of very long wavelength, is possible under the quantum rules for any molecule composed of unlike atoms. What prevents this from happening appears to be the absorption of sunlight by the molecule. This tends, on the average, to increase the rotational energy, and may undo the first effect, or strike a balance where the two compensate one another.

This reasoning explains also what would otherwise be very puzzling. The carbon bands, produced by the C_2 molecule, show evidence of many rapidly rotating molecules, corresponding to a rotation temperature of 3000 degrees. But this molecule, being composed of two identical atoms, cannot unload its energy by the "pure rotational" transitions — they are forbidden by the quantum laws. Hence, the absorption of sunlight would gradually build up the average rate of rotation to a high level.

There remains a fairly conspicuous group of lines or narrow bands in the violet (between 3980 and 4130 A) which has not yet been identified and presents one of the last unsolved problems of astronomical spectroscopy.

While this remains a mystery, another important problem has just been solved. We have spoken before in these columns of the interstellar lines which are absorbed by atoms scattered with extreme sparseness in the depths of space remote from the stars. Besides atoms of sodium, potassium, calcium, titanium, and iron, the familiar molecules CN and CH have been identified — but by very curious-looking spectra. During the extremely long times of isolation in interstellar space, a rotating and oscillating molecule has time to make the transition, step by step, to lower states. Being free from stimulation by near-by stars, such molecules should practically all be in the rock-bottom ground-state of lowest energy, beyond which it is not possible to go. A molecule in such a state can absorb but one, or at most two or three, of the lines in the corresponding band — so that a whole complex band-system containing thousands of lines will be reduced to one line where each of a group of many-lined bands is normally found. These lines, moreover, correspond to a transition from the state of lowest possible rotation to the next, and are usually faint in comparison to other lines of the band, corresponding to more rapid rotation. A thorough analysis of the bands, however, points with certainty to the particular line in question.

After these highly simplified spectra had been identified, four sharp interstellar lines remained. Discussion of these at a conference on interstellar molecules at the Yerkes Observatory led to the suggestion that three of them (with wavelengths 4232.58, 3957.72, and 3745.33), which were spaced about as the residual lines of three band-groups might be expected to be, might arise from some ionized molecule, such as CH^+ or C_2^+. Returning to the University of Saskatchewan, Dr. Herzberg, with his colleague, Dr. Douglas, proceeded to make molecules of this sort by the effective method of passing a discharge through helium containing a trace of the vapor of benzene, C_6H_6 — a heavy molecule which can be broken up into all sorts of pieces. Three new bands appeared in the spectrum, with heads at 4225, 3954, and 3743. The individual "rotational" lines in these bands were widely spaced, a proof that they come from some very light molecule — indeed, from one containing a hydrogen atom. Analysis of the structure served to identify the residual lines of the three bands, which were at 4232.57, 3957.71, 3745.30 — agreeing within the errors of measurement with all three interstellar lines. More detailed study of the bands showed that they were of a type which could be produced only by CH^+ among those molecules whose spectra were not already known.

As neutral CH molecules were already known in interstellar space, the presence of such molecules in the ionized state might have been anticipated. Only one sharp interstellar line at 3579.04 remains unidentified. The chance that it may turn out to belong to some other ionized molecule now looks good.—*Princeton University Observatory.*

How They Do It

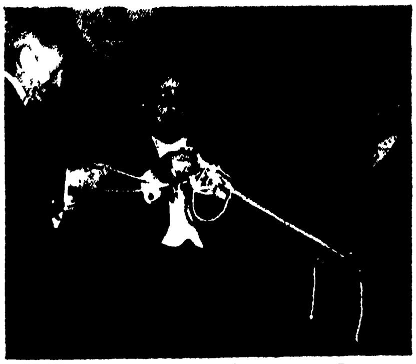
By Prestidigitation, Dunninger Duplicates "Phenomena" that have Fooled the Public

ON THE evening of November 10, 1941, members of the Scientific American Committee for the investigation of Psychic Phenomena, their guests, and representatives of the press assembled in a room in the Waldorf-Astoria hotel, in New York City. The purpose of the meeting was educational, for Dunninger, Chairman of our Committee, proposed to produce some of the more noteworthy "phenomena" he has witnessed during his more than a score of years as researcher in the realm of the occult. In duplicating these so-called psychic spectacles, two purposes were accomplished. The extent to which modern conjuration may offer delusion and deception was demonstrated, and bogus mediums, who have presented — and who still present — "phenomena" which are demonstrably hocus-pocus, and by which the public is annually bilked of an estimated 50 million dollars, were exposed. That legerdemain, prestidigitation, and certain types of mechanical artifices performed by and in the hands of a clever operator can completely bemuse an audience of higher than average mental caliber was conclusively proved at this meeting.

Our Chairman, one must remember, has been practicing the arts of deception for many years; furthermore, in the course of his investigatory work into psychic matters, first with Houdini and later on his own behalf, he has witnessed over 1000 so-called occult demonstrations of physical nature, all of which must be accepted as pseudo, for Dunninger has successfully duplicated by trickery or explained by natural means all of the "phenomena" that have thus far been brought to his attention. However, this must not be taken as an indication that either the Chairman or the members of our Committee are engaged in a "witch hunt." Far from it. Since the advent of Spiritualism in its present form, about 1848, too many unexplainable incidents have come to public attention to dismiss lightly, and as pure hokum, the theory of return to earth after death. If our Committee, individually or collectively, were of that mind, there would have been no need or excuse for the original organization of that body. To the contrary, and notwithstanding all other claims, the inquiry of the Scientific American Committee in the field of the supernatural in no sense questions any form of religious belief, nor does it seek to cast aspersions on any individual or group who may lay claim to super-normal powers. The indisputable truth about psychic matters is the aim of the Committee, but, by the same token, no credit or mercy can be extended to mediums or others whose practices are clearly shown to be nefarious and therefore not in accord with public welfare.

Dunninger; Miss Jane Schuele

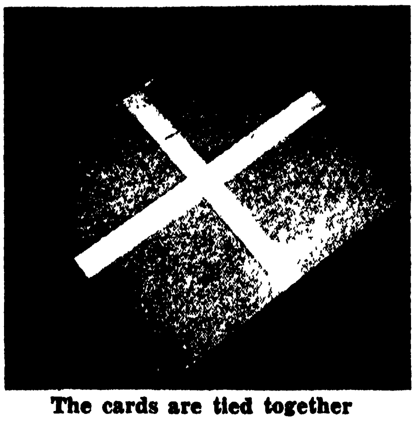
To emphasize how trickery can be utilized, Dunninger called two members of the audience to the platform and asked them to tie a number of simple knots simultaneously in two pieces of rope. While this was being done, he explained that Madame Stewart, a noted medium from Cleveland, Ohio, had based her claims to supernatural powers on ability to untie knots *in the dark*, while attendants at the seances held the four ends of the two ropes. In a room flooded with light, two men chosen at random from the audience each held two ends of the dual ropes while the magician proceeded to untie them. Never once did the ends of the rope leave the hands of the witnesses.



These knots disappeared

TO ASSIST in his next demonstration, the Chairman requested a young lady, Miss Jane Schuele, to be seated at a small table opposite him on the platform, with her back to the audience. He displayed a stack of ten small slates, which were placed on the table. He then asked Miss Schuele to write on a slate the name of a deceased friend or relative and the date of the demise. This she did in such a manner that no one could see what had been written and then laid the slate, writing side down, on top of the pile. Dunninger picked up what he termed his "concentration slate," a larger edition of the one Miss Schuele had used, and placed it over the top of the stack of slates. Drawing a chalk line on the large slate, he termed this "the concentration line." Leaning back in his chair, he lifted his "concentration slate" from the pile of smaller ones and gazed at it, meanwhile requesting Miss Schuele to concentrate as intensely as possible on the chalk line. Without hesitation, he then gave the name that had been written on the smaller slate and the date of that person's death.

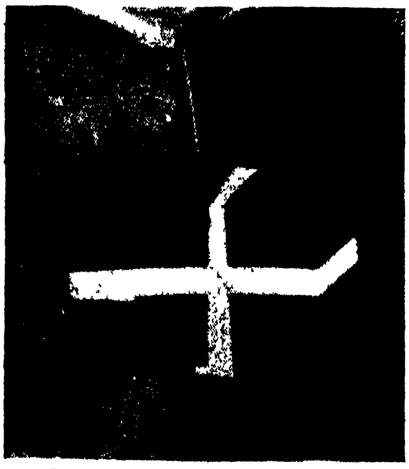
This was temporarily mystifying, but when the Chairman changed



The cards are tied together

places with Miss Schuele at the table and repeated the trick, asking the young lady for a different name and date, the audience saw clearly how the apparently amazing effect was so simply accomplished. As the magician leaned back in his chair and picked up the "concentration slate," he also picked up the top one of the smaller slates — the one with the message on it. This was easily done, for the inner edges of the frame of the "concentration slate" were made to fit perfectly around the outer edges of the slate which bore the message. As that slate had been placed message-side down on top of the pile, the writing appeared to the manipulator when picked up simultaneously with the "concentration slate," but not to Miss Schuele, nor, in the first instance, to the audience.

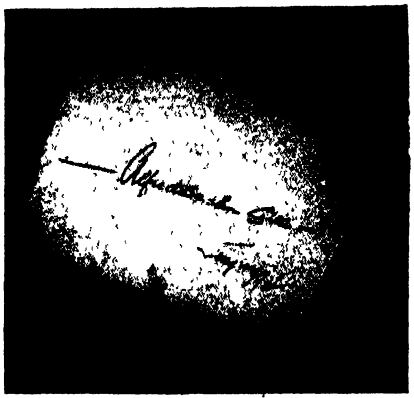
The term "independent writing" has in modern times been applied to many forms of supposedly mysterious appearances of writing on a slate or a piece of paper, and various methods and rituals are used in the course of its production. (July and August 1941). To demonstrate one of these, Dunninger called two representatives of the press to the platform. They were Mr. Robert Dunn, of *King Features*, and Mr. Phil Hamburger, of *The New Yorker*. Handing each man a piece of ordinary cardboard about six by nine inches, he asked them to sign their names on one side of their cardboard. Then, to insure that the witnesses would see *both* sides of the cards before and after the trick was completed, he had them exchange cards and autograph the remaining blank sides, which left a Dunn and a Hamburger signature on either side of each card. After the cards were given to the two men for signature, Dunninger did not handle them. The witnesses placed the cards together, tied them with a ribbon and placed them in a strong box provided by a member of our Committee. They locked the box and retained the key. The strong box, without being touched by Dunninger, was securely taped, hooked to a rope which was thrown over the top of a 9-foot screen, and hauled up in plain view of the audience, where it remained for approximately an hour while other demonstrations were presented.


Suspended before all eyes

For the denouement of this trick, a New York telephone book for the borough of Manhattan was utilized. Dunninger asked a member of the audience to open the book at random. The magician held the book spread out at the designated page, requested another member of the audience to take pencil in hand and, by making a circular motion, to mark any name on the two open pages. The man revolved his pencil several times in mid-air, then brought the point down. It came to rest on the name of Alfred Sasha Gill. The name was read from the book by the witness and underscored so that others might corroborate his statement.

Messrs. Dunn and Hamburger examine the names, find Gill's

Messrs Dunn and Hamburger were now recalled to the platform. Together they removed the strong box from the rope, tore off the tape, and unlocked the box, which at no time was touched by Dunninger. Somewhat gingerly, as though fearful of what they might find, the witnesses removed the cards, still fastened together by the ribbon, which they now untied. Each quickly looked at his card to determine whether the names were still there. Not only were the two names present,, written in ink, but also, scrawled in heavy black pencil on one card was the name — Alfred Sasha Gill! For the sake of emphasis, it must once more be repeated that after handing the cards to Messrs. Dunn and Hamburger for their signatures at the beginning of the trick, Dunninger did not lay hands on them again, yet the name of Alfred Sasha Gill, chosen from the telephone book by a third and independent witness, after a fourth had blindly selected the page, was clearly apparent to all.


From 'phone book to card

As everyone present knew, and as Dunninger forcefully stated, each of these "phenomena" had been accomplished solely by trickery, motivated by digital dexterity acquired through years of assiduous practice. Performed by a man who, among other accomplishments, is admittedly a magician, they were breath-taking, interesting, and entertaining. But, those identical feats of legerdemain, presented under the spell of darkness, or soft lighting — possibly with a subdued musical accompaniment and the intriguing odor of incense permeating the room — have been called "psychic manifestations" by the medium conducting the seance. With that sort of bogus performance, our Committee has no patience. We still, however, seek the truth concerning the physical type of psychic phenomena, and welcome all sincere offers of assistance and information.

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. ●

Dr. Carrel's Immortal Chicken Heart

Present Authentic Facts about This Oft-Falsified Scientific "Celebrity"

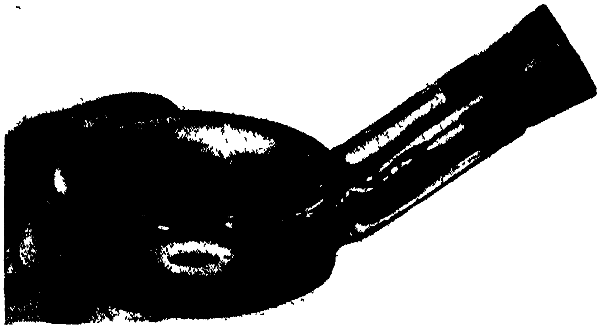
ALBERT H. EBELING, M.D.
Lederle Laboratories, Inc

A TINY fragment, removed in 1912 from the heart of an unhatched chick embryo by the eminent Dr. Alexis Carrel, began then the most extraordinary career ever enjoyed by a chick or a part of a chick. It has attained potential immortality. The present descendants of the cells in this fragment, now spoken of as Carrel's immortal chicken tissue, or the "old strain," are in their 30th year of independent life in the wholly artificial environment of laboratory glassware. Their growth is independent of time. Under the established conditions, the cells do not grow old, and now, after practically three times the lifetime of a normal chicken, they are as young and healthy as ever.

The Carrel tissue, and others similarly cultivated, daily perform important services to advancing medical science. Independently growing cells, able to convert nutrients into new cells of their own kind, possess unique value as reagents for investigating biological problems. They are released from the natural defenses that protect organisms and hence respond freely to changes in their environment.

The scientifically important researches conducted with the "old strain" have filled volumes of reports. Among them, for example, have been studies of changes in environment on cell growth and cell characteristics. It has been found that blood plasma, included in the tissue culture medium, exerts an effect on the rate of growth of the cells varying with the age of the animal supplying it. Thus changes accompanying aging have been studied.

The history of the "old strain" is closely bound up with the progressive development of tissue culture technique as carried out in Dr. Carrel's laboratory. The procedures are used in the cultivation of numerous pure strains of cell types other than the original "immortal chicken tissue" of Carrel, such as, for example, various types of epithelial cells, cartilage, thyroid, liver, certain cell types from the blood as well as various strains of malignant cells (sarcoma and carcinoma), in a known condition of activity and on media of almost unvarying composition.



Lederle Laboratories photo

This is *it*—the famous culture as it is kept

One important use of tissue culture is in the study of the mysterious viruses, potent causes of many diseases—among others, influenza, measles, and poliomyelitis (infantile paralysis) in man, and distemper, rabies, and encephalomyelitis in animals. Viruses, so far as is now known, will grow only in the presence of living cells. In ordinary living tissue the native defenses of the organism against external harm affect the growth of viruses. Consequently a controlled environment must be created to permit their cultivation for study. That situation exists for certain viruses in tissue cultures. A few viruses will grow in the pure strain of the original Carrel tissue. Others require the favorable environment of cultures of other tissues grown by the technique developed by Carrel.

The many years the cells of the "old strain" have been under cultivation and the constant conditions under which they are maintained cause them to grow steadily, independent of time. They multiply—proliferate—at an unchanging rate, and their characteristics are well known and invariable. Their long pedigree and the mass of information accumulated about them in nearly 30 years make these cells the best possible material for testing the effects of a large number of substances of clinical and commercial value. For example, with them much can be learned about the action of drugs, such as those of the sulfanilamide family, upon living tissue. Similarly, they provide a unique way of studying the antiseptic action of germicidal compounds. To be a safe antiseptic, a substance must be more toxic to bacteria than to the healthy tissue of the wound to which it is to be applied. This is not true of many germicides. The all-important toxicity ratio — the dilution of a substance required to kill a standard bacterial culture, compared with the dilution that kills a culture of tissue cells—can be directly and accurately determined with this tissue. The standard strain is being widely used in tests of this sort at Lederle Laboratories and has already thus "earned its keep" over and over again.

Although this tissue's history is sufficiently impressive without embellishment, legends, some of them fantastic, have grown up about it. In these tales Dr. Carrel's original tiny fragment of chick embryo heart-tissue has grown into a large, pulsating chicken heart; or pieces have to be "snipped off" from time to time to hold it in bounds; or it is being kept in a glass jar or on a white marble slab, with the added setting of a group of scientists crowded around intently watching and tending it constantly, day and night!

YET, even though the simple facts lack some of the drama of the legends, they are important and no less interesting. On January 17, 1912, a minute piece of heart muscle was removed from an unhatched chick embryo. This tiny fragment, during repeated transfers into fresh nutrient medium, pulsated for a little over one hundred days after its separation from the orginal heart. By that time connective tissue cells—fibroblasts—which also were present in the original fragment, had gradually outgrown the muscle cells. The result therefore was ultimately a pure strain of fibroblasts, which pulsed no more. These cells have the property of continuing to form a network of tissue in a wholly artificial environment, not as part of a chick.

They multiply today as actively as they did at the beginning of their artificial life. The rate of growth has not diminished and they are constantly maintained under conditions favoring their optimum multiplication.

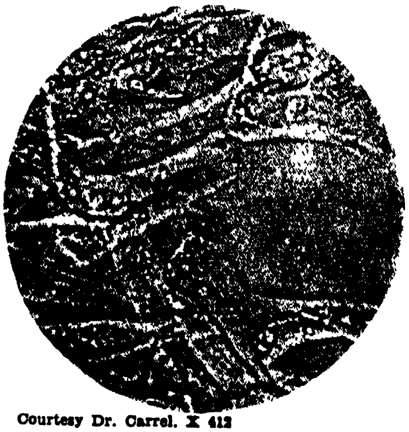
Lederle Laboratories photo

This technician is transferring tissue cultures and giving them fresh medium in which to grow. Test tubes at left contain culture medium. Carrel flasks, in which tissue is artificially grown, are at the right. Black clothing and black surroundings reduce reflection of light and improve the technician's level of visibility in performing this exacting work

The strain of cells is now in its 30th year of life outside of the organism from which it arose. In other words, it is potentially immortal. This is not a probability, but an irrefutable fact. In a few cases chickens have lived over 20 years, but the average lifetime of the barnyard fowl, if it can escape the axe, is not much over ten years Hence, these cells derived from the chick embryonic heart muscle in 1912 have far outlived the chicken into which the embryo would have developed in the natural course of events.

If it had been feasible to keep, and nourish, every sub-culture that could have been derived from the original tiny fragment of heart, dividing each in turn *ad infinitum*, the mass of tissue would now be far larger than our whole solar system could contain. That, of course, sounds fantastic, yet it is mathematically demonstrable.

As the culture continually tends to form a more or less compact mass of tissue that doubles in size every 48 hours, each fragment must be subdivided, if its bulk is to be kept within practicable limits. Moreover, nutrition, respiration, and elimination of waste products are limited by the size and by the physical, physiochemical, and chemical conditions of the culture. For these services the cells depend upon the diffusion of substances through the semi-solid, jelly-like medium in which they are kept. Thus, if the culture were allowed to grow into compact masses, then those cells in the thickened portion would suffer from lack of proper nourishment, sufficient oxygen, and removal of waste products. Some cells would die, others would be poisoned, and total death of the culture might result.



Courtesy Dr. Carrel. X 412

Living old strain fibroblasts

Actually, therefore, the average individual piece of tissue that is transferred to fresh medium is not larger than the head of a pin.

When the strain was started in 1912, it was necessary to transfer the tiny fragments every 48 hours, but later the method was modified and now transfer to new medium is less frequent.

The strain is ordinarily kept in small, flat, tightly-stoppered glass containers—Carrel flasks. The Carrel flask,developed for this type of cell culture, is made of Pyrex glass an inch and a half in diameter, about half an inch high, with an oblique neck. The amounts of nutrient medium and air in a flask are large in proportion to the total mass of tissue, so that several fragments (from two to four) can be kept in one flask, and transfer to a fresh medium need be made only every seven or eight days. The life processes—metabolism—of the tissue produce no dangerous variations in the condition of the medium during the length of its stay in a flask. Any surplus tissue is discarded at the time of transfer.

In all the procedures involved in the cultivation of these cells, rigid aseptic precautions must be taken at all times; that is, the cultures must be kept completely free from bacterial contamination. The medium best suited to maintain the optimum multiplication of these cells is composed of chicken plasma, chick embryonic juice, and Tyrode's solution, mixed in certain proportions. Each of these constituents of the medium is especially prepared for the purpose.

Plasma, the clear fluid part of blood, is obtained by bleeding an anesthetized chicken from a suitable artery under aseptic conditions and separating the cell elements—corpuscles—in a centrifugal machine. The clear fluid that constitutes the plasma is drawn off and preserved in a refrigerator.

Chicken plasma obtained under proper conditions will remain fluid for weeks, and thus can be stored for use at any time.

The embryonic juice is prepared by finely mincing the tissue of unhatched chick embryos and separating the fluid part. This juice also can be stored in the refrigerator for use. The embryonic juice contains most of the essential nutritive as well as growth-promoting substances required by the cells for their continuous multiplication. Some essentials, of course, are furnished by the constituents of the plasma.

Courtesy Dr Carrel X 412

Stained old strain fibroblasts

Tyrode's solution is a solution of several salts and glucose. It acts as a diluent for the plasma and tissue juice, and supplies certain metals essential to cell growth.

When the medium is needed, plasma is combined with the tissue juice and salt solution. Soon after these constituents are mixed, coagulation — clotting — occurs. Hence, it is necessary to introduce the medium into the culture flask and, while still fluid, submerge the tissue fragments in it. Then, when the whole is left undisturbed, a soft, uniform clot quickly forms. This is firm enough to hold the tissue fragments in place and, at the same time, to furnish an invisible, fibrinous network in which the cells can multiply, and through which the fluid part of the medium and oxygen (from the air contained in the flask) can diffuse to reach the cells.

During their stay in the flasks, the cultures are bathed at intervals by introducing a quantity of Tyrode's solution, leaving it for a time, and then withdrawing the fluid by gentle suction in order not to disturb the coagulum. After this washing to remove waste products, fresh, diluted embryonic juice is added to replenish the food supply. Enough air enters the flask during the manipulations to renew the oxygen supply.

Microscopic observations of the cultures can be made at any time at moderate magnifications. For high magnification (1000 diameters or more), fragments of the tissue can be transferred to specially constructed containers—microflasks—which have paper-thin glass walls. Also, cell behavior in these flasks can be permanently recorded by micro motion pictures.

In July, 1939, Dr. Alexis Carrel retired from the Scientific Staff of the Rockefeller Institute for Medical Research. His department, the Division of Experimental Surgery, was discontinued and his organization dispersed. The writer, who was associated with Dr. Carrel for over 27 years, brought the "old strain" to the Division of Virus Research at the Lederle Laboratories in Pearl River, New York. Here, in a well equipped, modern tissue-culture laboratory, the strain continues to live uninterruptedly. Two former technical assistants of Dr. Carrel, Mrs. E. Hull and Miss D. Olmstead, are responsible for the important work of maintaining the stock cultures.

No other laboratory in the world possesses this strain under cultivation. Through the years, Dr. Carrel gave cultures of it to various individuals in research laboratories here and abroad. There is no record of any of them having survived. Hence these laboratories have the unique distinction of being the sole custodians of Dr. Carrel's original, potentially immortal strain of cells.

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IN BIG DEMAND: In the entire nation there are less than 5000 physicists, and of these between one third and one quarter are already engaged in defense work.

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CRYSTALS

Structure Demonstrated

By Steel Balls

STEEL ball bearings are used by scientists to study the structure of all sorts of materials. Dr. Ralph P. Johnson, physicist in the General Electric Research Laboratory in Schenectady, is shown in one of our photographs, stacking up a model of a face-centered cubic crystal, such as is found in aluminum, silver, gold, calcium, copper, lead, and a number of other elements. Each steel ball represents one atom and is about 20,000,000 times the size of the real thing.

All crystalline substances have a specific geometrical arrangement of atoms which assists the physicist in identifying the material. The face-centered cubic type, as illustrated by the arrangement of the steel balls, is one in which each atom in a crystal is the center of a spherical cage formed by twelve surrounding atoms.

More than one material may have the same geometric arrangement of atoms. Once this type has been determined, usually by observing the pattern of diffraction of X-rays, the physicist distinguishes members of the group by the size of the atoms.

The arrangement of the steel balls shown in the picture is the densest that can be obtained. If a large number of similar balls were dropped at random into a pail, many would naturally fall into this arrangement. The group as a whole, though, would be more loosely packed than the balls arranged by Dr. Johnson

In the background is shown the atomic arrangement of crystals of table salt, iron, and calcium carbonate. The square-block framework represents an iron crystal; the crystal of single-size spheres represents table salt; and the model containing spheres of two sizes represents a calcium carbonate crystal.

They represent atoms

Wheat Peeled For Better Bread

Process Developed by Mining Engineer Retains Grain Elements, Eliminates Fibrous Husks

H. T. RUTLEDGE

Peeling the wheat grain of its husk without cracking or injuring the kernel has been tried countless times, but each attempt to accomplish the feat in the last hundred years of milling in the United States has ended in failure. This peeling is desirable in order to produce flour from the wheat that retains all the desirable elements of the grain, without the splintery, indigestible husks, yet inventors and milling experts had reached a point where they were ready to declare that the task was impossible. They never dreamed that the job might be done by someone who did not have the remotest connection with milling or baking—but that is exactly what happened.

The wheat-peeling process was discovered in 1937 by Theodore Earle, of California, a mining engineer, who admittedly knew nothing of milling methods or milling machinery. Experimental tests continued and data on the process were checked for the next four years.

The Earle process was not originally aimed at wheat-peeling. Rather, it grew out of tests with seeds, made with mining machinery—flotation cells of the type used to separate precious metals from baser elements. After many experiments, Earle discovered that grain seeds classify themselves, when subjected to the flotation treatment, into "tails"—seeds that come to the top—and "concentrates"—grains that remain at the bottom of the flotation cells. Tails in wheat are found to be superior for milling purposes while concentrates are superior for planting because they yield the better crops.

In a series of three tests of seeds so classified, conducted by the Kansas Wheat Improvement Association and the United States Department of Agriculture Bureau of Plant Industry at Hays, Kansas, the concentrates disclosed increased per acre yields of 22 percent, 7.1 percent, and 11 percent over those per acre yields of untreated wheat grain seeds. In the first two tests, the seed beds were cropped land; in the third test, the seed bed was fallow land. In all three tests, the same wheat grain variety was used

Mr. Earle combing the slurry from an experimental flotation cell

Earle's chief interest, from the beginning of the experiments, was in the germination or fertility quality of seeds. He did not set out to find a way to peel wheat kernels of the fibrous, splintery, indigestible husk, or epidermis, that has been blamed for many gastric disturbances. Discovery of the peeling process occurred quite by accident.

In one test, wheat grains were mixed with water in a single flotation cell. The mixture was placed in agitation and then—the telephone rang. Earle answered the call but talked longer than he anticipated. When he returned to the cell, he found slivers of wheat husks floating on top of the water. He examined the grains and they were free of husks. That started the ball rolling. Dozens of follow-up tests took place in the ensuing months and finally the peeling process was perfected.

M. Lee Marshall, President of the Continental Baking Company, became interested in the achievement because one feature of the process was of particular importance: it removed the husk without cracking the wheat kernel. That meant that all the vitamin, mineral, and protein content of the wheat grain was kept intact. It meant, too, that these deposits would be ground into flour just as nature had stored them in the wheat kernel.

Here was big news to a baking executive who had been looking forward to the day when he might market a bread that contained the wheat vitamins, but not the scratchy husks which give whole wheat bread its bitter taste.

Preparation of the wheat for actual grinding under the Earle process combines many of the steps employed in ordinary modern milling. The flotation method unites with these steps to establish a smooth-running process that produces flour from which is baked *Staff*, a new, natural wheat bread.

The business of receiving, binning, and rough cleaning wheat under the Earle process is like that used by all good millers. Ten cells constitute the peeling machinery.

These are rubber-lined tanks, each equipped with a rubber-covered impeller. The grain is mixed with water in such proportions as to form a slurry that can be agitated by the cell impellers. The ten cells are linked at the bases by connecting pipes.

The slurry of wheat and water enters the first cell and undergoes agitation by an impeller. Then an edible re-agent is added to the slurry to form a froth which collects the feathery husks as they break away from the kernels. The slurry moves rapidly from cell to cell, the wheat husks, which millers call "bee-wings," amassing on top, the wheat kernels dropping to the bottom. The froth is skimmed from the tops of the cells as it thickens.

PASSAGE of the mixture from cell to cell occupies about nine minutes and the cleaned and peeled wheat leaves cell number ten to go to a vibrating screen that shakes much of the water from the kernel surfaces. The peeled grains then move into a whizzer, a continuous type of centrifuge, where more water is removed. From the whizzer, the kernels go to a dryer, through which flows a swift current of warm air. This dryer is a steel tube five feet in diameter and 30 feet long. It is fitted with a central flue and six concentric flues. Here the grains remain for about 12 minutes, moving at high speed and tumbling finally into the aspirator which takes out any specks of husks lodged in the kernel creases.

Still feeling moist to the touch, the grains flow to tempering tanks to remain several hours. When they emerge, they are externally dry. All moisture has been absorbed.

Now ready for grinding, the cleaned, peeled, dry wheat grains go to a battery of pulverizers of hammer-mill design and become flour containing the nutritive elements of the bran coats of the kernel, the vitamins (vitamin B_1, vitamin B_2, nicotinic acid), and the minerals and proteins of the berry, but free of the woody, outer coating.

The bread made from this flour contains 444 to 566 International Units of vitamin B_1 to the pound loaf, 1.02 milligrams of vitamin B_2 (riboflavin), and 12.7 milligrams of nicotinic acid. The methods used in these determinations were: (1) thiamin—biological, thiocrome, and fermentation: (2) riboflavin—microbiological; (3) nicotinic acid—colorimetric.

A typical freshly baked loaf of the bread reveals itself as follows in analysis:

Moisture	37.40%
Total Solids	62.60%
	100.00%

Composition of Solids

Protein	15.92%
Ash (less salt)	2.13
Salt (NaCl)	2.17
Crude Fiber	1.71
Crude Fat	6.31
Carbohydrates	71.76
	100.00%

A comparison of white bread, ordinary whole wheat bread, and the new peeled-wheat bread discloses that *Staff* contains 2.13 percent minerals as against 1.14 percent for whole wheat and 1 03 percent for white bread.

Dr. John R. Murlin, food authority, University of Rochester, New York, recently told the National Nutrition Conference for Defense that the only way to get all the nutritive elements of the wheat grain into bread is "by producing whole-wheat flour and making whole-wheat bread." He explained that his own experiments with a natural wheat bread disclosed the following story:

"The average per-capita consumption of wheat is four bushels, or 240 pounds. Deprived of its roughest constituent, 2 percent only, by weight, ground without sifting or bolting whatever, the amount will make 355 pounds of bread as compared with 221 pounds on a rich formula from 75 percent extraction of the grain.

"The 355 pounds of whole wheat, according to digestibility figures in a recent experiment in our own laboratory, on ten men, would yield 356,000 and some odd calories; compared with a white bread eaten by the same men, 240,000 and some odd calories, a saving of 116,000 calories, or enough to support the average man on our diet squad for 36 days. In other words, eating whole wheat bread would save over a year's supply of energy for yourself in the course of a year."

Thus, through the happenstance of a lengthy telephone call, a new type of bread that appears to hold promise of economy plus added nutrition has been made available. These factors, and the seed classifications made possible by the original flotation experiments, may mean much to the average bread consumer and to the farmer.

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Desert Alphabet

Strange Letters of Stone are Found in the Sand Wastes of South-western Arizona

JOSEPH C. COYLE

HIDDEN here and there in the mosaic of Yuma mesa, and buried in its topsoil, I find the letters of the alphabet. Some of them are scarce, but many letters are more or less plentiful and are remarkably perfect in shape. With the collection I have, I build many words, sentences, paragraphs.

One day an army plane roared just above my head. Involuntarily, I ducked. When I straightened up I held a perfect capital A in my hand. There were already a Y and a couple of Ls in my rock pile. I could now spell "Ally" with stone letters.

These stones range in color from light gray to nearly black, and most of them are so hard that they ring like cast iron when struck together. Some are shapeless and porous, but there are quantities of them, from the size of a straw to three inches in diameter, which closely resemble, in contour, fragments of petrified native wood. Nearly all are without a semblance of grain, however. The greater part are fairly straight and under 12 inches long, though I found one an inch in diameter and 64 inches long.

Cloudy days, though rare at Yuma, are best for rock hunting, since the sun's glare on the light-colored desert is then eliminated.

Second best is early morning or late afternoon, when shadows grow long and every pebble in the desert mosaic stands out against the drab background of gray sand.

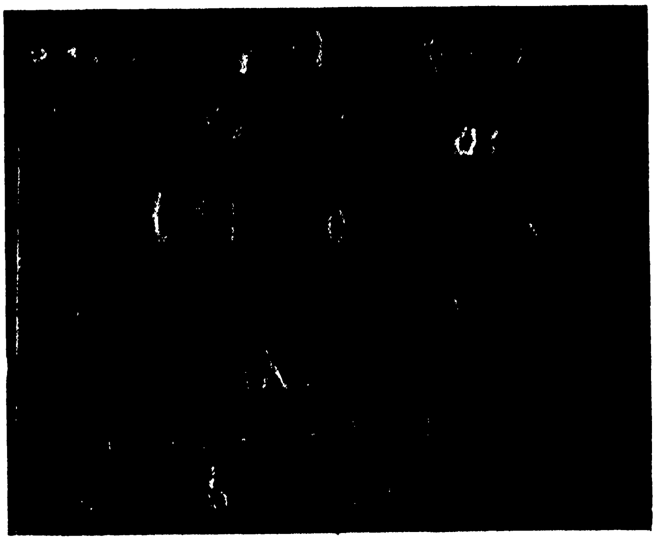
My stone vocabulary grew by leaps and bounds, but it still centered around words requiring Ls, Ts, Ys, and so on. One day I parked my automobile and stepped out. There lay a perfect Q I could now spell "quit," "quill." The letter O eluded me for a long time, but I now have several—some strikingly perfect. Although I wanted to spell out my name with the stone letters, the only Cs I found at first were imperfect, and E apparently was non-existent. Then one day I spied a very good capital E which a kangaroo rat had kicked out of his tunnel.

Many of the thick patches of specimens resemble closely in contour those of clumps of growing mesquite brush nearby. I was amazed to find a round stone about an inch in diameter and three feet long, with a groove cut by termites along one side; also logs, one of which is 30 inches in diameter and 20 feet long, outlined in porous stone and closely resembling cottonwood in shape. Stumps are outlined in the same porous rock, with stone roots radiating from them Underground, as well as on the surface, are long stone roots

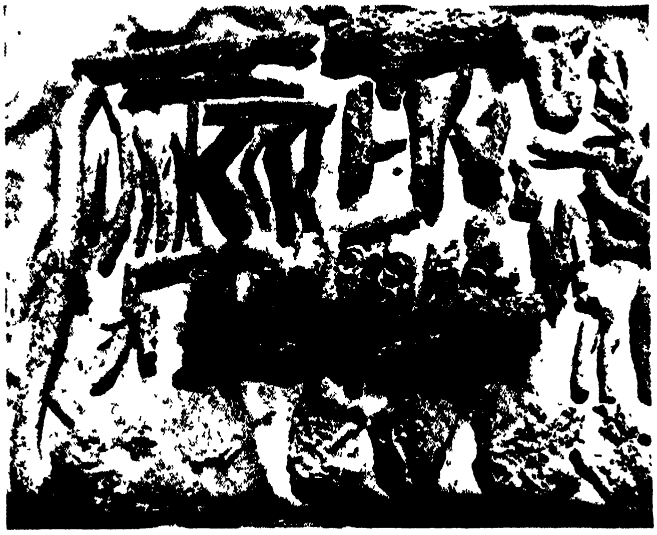
Formerly a five-foot root

A WELL-KNOWN geologist to whom I submitted the evidence stated that the specimens, when tested with acid, proved to be sand grains cemented by lime. Also that, judging from the photographs and the method of occurrence of the specimens, these undoubtedly were once plant roots and stems which, in decaying, left hollow spaces in the earth. Sand then filtered into the spaces and lime was added through the agency of percolating waters containing this mineral in solution. As the plant root fragments would have been branched in many cases, and later broken, the accidental resemblance of a few of the specimens to letters is expectable.

It is my own further hypothesis that the shape of many of these letters, as well as the other strange loops and crooks, has resulted from termites plastering the roots and stems of native wood and plants with their familiar tubes of sand, which then became consolidated into stone by the infiltration of water impregnated with lime, as just explained. The layers and folds of sand on the exterior of some specimens cannot be distinguished from fresh termite work, when the two are placed side by side. More than once I have picked up what I thought was a nice specimen, only to have the outside fall away, revealing a stick of wood which had been only *recently* plastered by the tiny insects. These specimens of termite work are often partially or wholly hollow, where the wood, covered with sand, rotted away before hardening took place. Crossed, branched, and crooked sections of these specimens later broke into sections resembling in some cases letters of the alphabet and various other things.



Found by the "rock russler," near Yuma



Further specimens of the same kind

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TROPOSPHERE

Studies Carried Out Near Sea-Level

COLDEST spot in the United States is not Havre, Montana, but in semi-tropical Santa Monica, in Southern California, where at one certain spot the average August temperature last summer was around *minus* 40 degrees, Fahrenheit, and frequently dropped to 104 degrees below zero! These temperatures were recorded in a scientific ice box located at the Douglas Aircraft factory where experiments for bombers operating in the frigid troposphere can be carried out at the more convenient ground level.

Function of the "cold room," say Douglas engineers, is to simulate the conditions and effects of extreme low temperatures on the various components of high-flying aircraft. Since, at 35,000 feet, the

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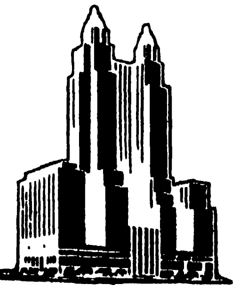
1. *This attractive living-room . . .*

2. *becomes, magically, a dining-room . . .*

3. *and, finally, a sleep-inducing bedroom.*

Inspection invited.
Descriptive booklet on request.



THE WALDORF-ASTORIA
PARK AVENUE · 49TH TO 50TH · NEW YORK

troposphere has a near-constant temperature of 67 degrees below zero, the men, motors, metals, alloys, plastics, and other materials used at such heights must be thoroughly pre-tested.

The trick is done with a combination of solid CO_2—dry ice—and methyl alcohol. Agitated together and pump-circulated through a heat-exchange unit, this mixture will reduce the temperature in the cold room from plus 80 degrees to minus 104 in two hours. This bit of Siberia in Southern California is contained in a space some 14 by 16 by 8 feet. The room is insulated with 12 inches of fire- and corrosion-proof spun glass.

"Our test program includes a study under polar conditions of fuel, oil, and hydraulic systems, controls, structural parts, insulation, heating, windshield de-icing devices, bearings, lubrication, tolerances, metal fatigue, and countless other subjects," explains the engineering department.

Despite extremely low temperatures, men are able to work in the room without too great discomfort. They wear sheepskin garments and wrap themselves into wool-lined leather suits surmounted by helmets equipped with earphones and a telephone mouth-piece. The helmet, greatly resembling a diving bell, is made of spun aluminum welded to padded shoulder pieces of the same material. It has a fixed vizor of laminated Plexiglas separated by air chambers and hermetically sealed after all moisture has been removed. This effectively prevents fogging. It is lined inside with orthopedic felt and soft chamois skin. Neither suit nor helmet is electrically heated.

Since a principal danger to workmen in the cold room is the possibility of pneumonia, the suits are valved so the wearer breathes air warmed by his own body, the large helmet providing ample storage space. The intake is near the floor; the exhaust is located in the helmet dome.

ANTI-FREEZE

Conserved With Cooling-System Sealer

CONSERVATION of automobile anti-freeze fluids, urged for this winter because of defense needs, gains an ally in a newly developed liquid cooling-system sealer announced by Du Pont.

Leakage and the subsequent

over-heating account for thousands of dollars worth of anti-freeze lost annually, radiator specialists point out. The new cooling-system sealer is an inexpensive "ounce of prevention," against such losses. It is said to be harmless to rubber, aluminum, and other metal engine parts, and to flow with water. It not only stops existing leaks without clogging, but prevents new leaks forming in the system. Before the sealer is used, the cooling system should be cleaned to rid it of rust and scale

RADIUM DETECTOR

Protects Those Working With Radium Compounds

An INSTRUMENT which sounds a warning signal and flashes a red light when the quantity of radium or radio-active materials in the vicinity is too great for workers' safety has been designed by the Geophysical Instrument Company. The instrument, which employs a Geiger-Muller counter tube and an auxiliary circuit including standard vacuum tubes, also indicates the concentration of radioactive materials on a dial. Furthermore, it is possible, with this instrument, to check the strength of radium compounds in order to determine whether or not any such material has been lost

ICICLES

Movies Use Cellophane And Waterglass

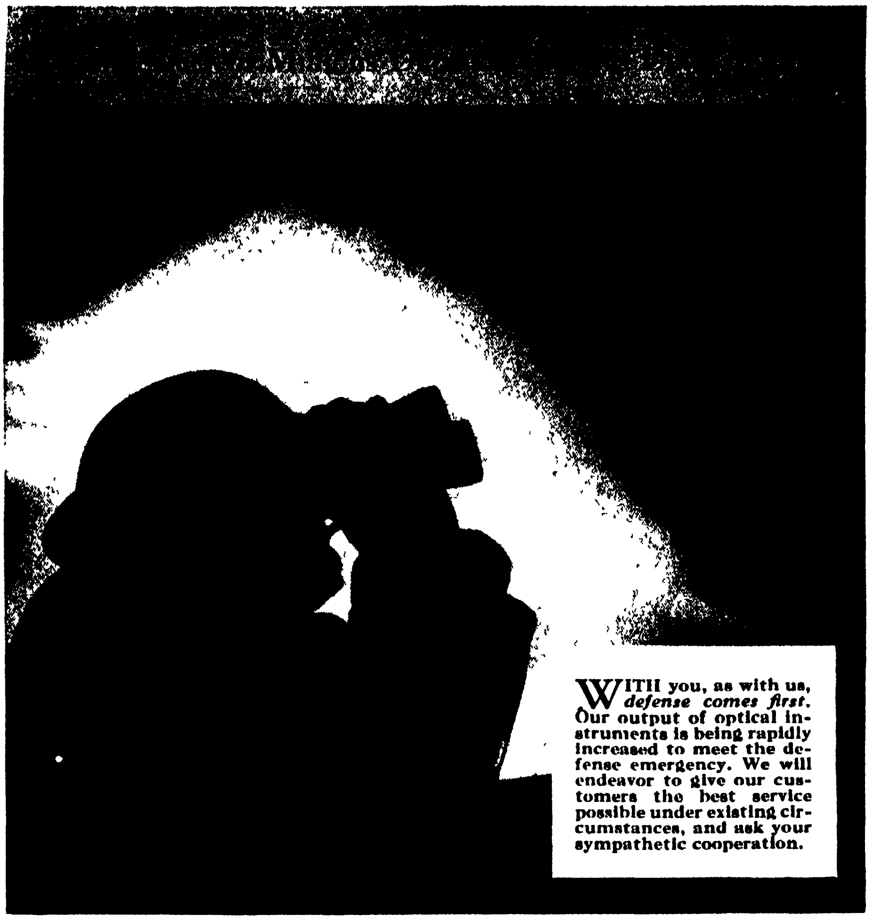
CHEMICAL icicles are used on many of Hollywood's movie sets The icicles are made of cellophane and waterglass — the substance used to preserve eggs. After being shaped they are dipped in alcohol, which solidifies them, and then in paraffin. The latter forms a coating which melts under the heat of the spotlights, giving a realistic effect.

PANELS

Of Light Weight For Transport Use

A MATERIAL which is establishing itself as being of particular interest to designers in the transportation field is Fybr-Tech, one type of which is being used as an interior lining for the huge flying boats which Vought-Sikorsky is building for the transatlantic service of American Export Airlines, Inc. The panels developed for this purpose weigh only one-fifth of a pound per square foot as compared with the average wall paneling weighing one to three pounds per square foot. This type of Fybr-Tech developed has a fiber face for strength, a balsa core for lightness, and a walnut face for beauty. This American walnut paneling is the key note of the decoration of the entire passenger accommodations in the new transatlantic flying boats.

This was, in a sense, an extreme and unusual form of Fybr-Tech; however, the principles involved in the material's construction are flexible, various factors being introduced to suit whatever application it is intended for. For surface transport use, a more orthodox construction of Fybr-Tech is used consisting of two faces of fiber with a birch or basswood core. With this a great increase in strength is gained with a certain sacrifice in weight, but both are present in sufficient proportions to make this form an efficient substitute for aluminum and other metal sheet in certain applications.



WITH you, as with us, *defense comes first.* Our output of optical instruments is being rapidly increased to meet the defense emergency. We will endeavor to give our customers the best service possible under existing circumstances, and ask your sympathetic cooperation.

THROUGH the cold dank dusk a watcher scans the gaps between the scattered clouds His first glimpse of oncoming bombers sounds the alarm that sends thousands to the safety of their shelters and the defenders to their duties. Four thousand miles away, aboard a heavily laden freighter, the captain studies the silhouette of a ship on the horizon, to determine whether friend or foe. This is serious work for binoculars, work worthy of those known as the world's finest

Bausch & Lomb is a builder of such binoculars. Producer, too, of many other instruments that utilize the principles of optical science to the advancement of the common good; of metallographic microscopes, through the use of which research physicists obtain more nearly impenetrable armorplate—or build extra thousands of miles into your next automobile engine; of spectrographs that analyze the chemical composition of crude oil—or of a die casting; of spectacle lenses that open up a world of learning to a school child whose mind might have been dulled by defective vision.

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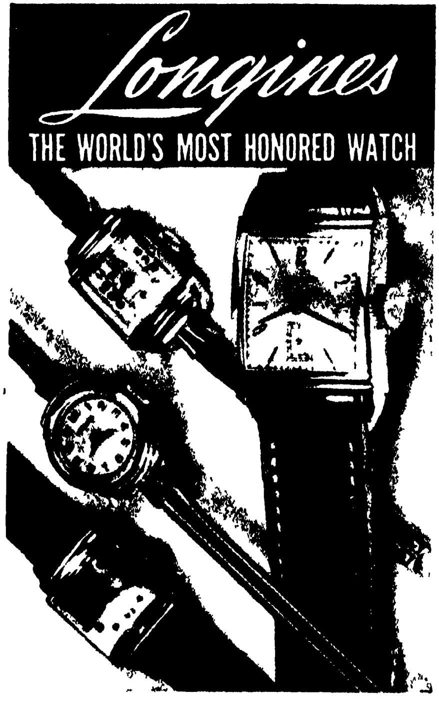
THIS YEAR more people will receive Longines Watches for Christmas than ever before. And this year, many who want them will be disappointed. We are sorry, there will not be enough Longines Watches to go around. Longines, the world's most honored watch, has won 10 world's fair grand prizes, 28 gold medals, and more honors for accuracy than any other timepiece.

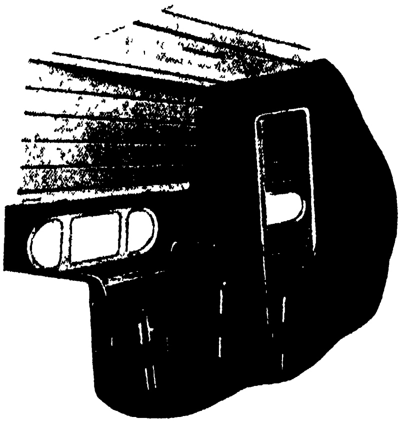
The new 75th Anniversary Longines Watches are now shown by Longines jewelers, priced $44.00* upward; see also the Wittnauer Watch, a companion line of moderate price, from $27.50*—products of Longines-Wittnauer Watch Co., Inc., New York, Montreal, Geneva.

*Federal tax included



Greyhound buses alone, for example, have used over a quarter of a million feet for this purpose, while another manufacturer of buses will use large quantities of the material in their new models.

Among the advantages of this material for transport use is the fact that it is extremely easy to work; it may be cut, drilled, die-punched, and bent to a radius of as little as one-half inch. It is resilient and will not dent easily; it has a tough, hard surface which will take a fine paint finish. It can be waterproofed, and used in conjunction with metal for unusual strength, asbestos for fire-resistant qualities, hollow-core construction for extra lightness, and with a veneer face for decorative trim.


Flying boat interior

VENTILATING

System Speeds Up Tunnel Boring

Six feet per day have been added to the push in the east portal of the 13-mile-long Continental Divide tunnel, being driven by the S. S. Magoffin Company at Estes Park, Colorado, since the recent installation of what is believed to be the most efficient and effective method of tunnel ventilation ever devised.

The ventilating system consists of heavy-duty blowers powered by General Electric 2200-volt, 100-horsepower motors, connected to the blowers by means of V belts. As the work progresses, the blowers are being installed every 9000 feet along the tunnel.

The installation of this ventilating system has cut twenty minutes from the time needed for each drilling cycle. So effective is the system that the men working in the heading can now return to their posts immediately after shots are fired, instead of waiting for the smoke of the explosion to clear.

In addition to removing smoke from the bore, the ventilating system can be regulated to overcome the fog usually prevalent in a tunnel because of the difference in the temperature of the air at the portal of the tunnel and at the heading.

After holes have been drilled by the crew in preparation for blasting, the fans are shut down while powder is placed in the holes. The charge is then fired electrically. Immediately after the shot is fired, the operator in the compressor house at the portal of the tunnel—from where the blowers are controlled—is notified by telephone and the fans are started to exhaust the bad air from the tunnel.

Twenty seconds after the blower in the heading of the tunnel starts, the next blower starts, and so on down the tunnel. This allows sufficient time for the air to reach each blower, thereby eliminating the possibility of a vacuum being created in the duct with a resulting inrush of air which might damage the blower or duct.

The fans exhaust for approximately 20 minutes, sucking all the powder smoke from the heading, and are then reversed to blow fresh air into the tunnel. After the "reverse" push-button is pressed, the motor in the portal of the tunnel delays one minute and then starts up in the opposite direction. This allows sufficient time for the motor to come to a rest before changing direction; plugging is thus prevented.

Twenty seconds later, the second blower picks up; the remaining motors start at 20-second intervals. The fans blow fresh air into the tunnel for about 30 minutes

Clear air, 9000 feet in

One of a series of blowers

and are then again reversed. Exhausting is continued until the heading crew is again ready to shoot, when the fans are shut off and the procedure repeated. This system requires only one pipe to supply fresh air and to exhaust bad air, and is much more economical than a double blower system.

Blowing and exhausting are timed to conform with outside temperature, to avoid fog collection in the tunnel In this way, the heading of the tunnel as well as its complete length is always free from smoke and fog.

When completed, the fifty-million-dollar Continental Divide Tunnel will connect Estes Park and Grand Lake, Colorado, to bring water from the western slope of the Continental Divide to the eastern side, where it will be used for irrigation In addition, immense quantities of power will be developed by the installation of turbo-generator units at strategic points The project is under the direction of the United States Bureau of Reclamation.

• • •

RAILROADS: Rails in present-day use on American railroads range in weight from 50 to 150 pounds per yard.

• • •

PUTTY

Remains Plastic, With Hard Skin

A NEW putty for glazing, sealing, and caulking that remains soft and pliable on the inside yet hardens to a protective skin on the outside has been made available by the Tamms Silica Company. It is claimed that the material will expand and contract with temperature changes and will not crack, crumble or fall off.

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CENTRIFUGAL

		Inlet	Outlet	Price	With A. C motor
No 1	Centrifugal	1/4"	1/8"	$ 6 50	$25.00
No 4	"	3/4"	1/2"	13 50	32.00
No 9	"	1 1/4"	1 "	16 50	35.00

No 1½	Gear	1/8"	Price $ 9 00	With A C. motor	$25.00
No 2	"	1/4"	" 10.00	" " "	27.50
No 3	"	3/8"	" 11 50	" " "	28 50
No 4	"	1/2"	" 12 50	" " "	32 00
No 7	"	3/4"	" 15.00	" " "	37.50
No 9	"	1 "	" 16 50	" " "	49 50
No 11	"	1 1/4"	" 48 50	" " "	on request

COROZONE OZONATOR

An electrical device that converts ordinary oxygen into ozone Revitalizes and deodorizes the air Suitable for laboratory, factory, office or home 110 volt AC Only 10 watts. **$9.50**

Exhaust Fans, Bucket Blade, G. E. A.C. 110 volt motors.

	RPM	cu ft per min	Price
9"	1550	550	$12.00
10"	1500	550	13 50
12"	1750	800	18.00
16"	1750	1800	19.50
16"	1140	1650	27 50
18"	1750	2500	22.50
18"	1140	2100	32.00
20"	1140	2800	36 00
24"	1140	4000	42.00
24"	850	3800	45 00

Other voltages & frequencies available at slightly higher prices

Synchronous Motors

New Emerson 100th H P, 900 R P M 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount no base Has many applications $7 50

General Electric Immersion Heaters

Suitable for heating liquids, tanks, kettles, etc (1 KW raises temperature 100°F 3 gallons per hour) Fitted for 1½" iron pipe thread Can be used as 110, 220 volt or 3 heat 110 volt

600 Watt	$7.50	1200 Watt	$10.50
750 "	7.50	2000 "	12.50
3000 Watt	$15.00		

We have on hand a large variety strip (space) heaters Quotations on request

Small Piston Type Air Pump

Can be used for all purposes where low pressure air is required Develops 1/3 cu ft of air at 15 lbs pressure Suitable for aquariums Takes care of 6 to 8 tanks Piston type, all brass cylinder Belt driven Universal AC-DC motor Mounted on neat oak base

Complete **$7.95**

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This metal mercury switch overcomes faults of usual mercury switches May be turned a full 360° Has thousands of known applications from tiny lab instruments to gigantic power controls

1 Amp	$1.10	20 Amp.	$3.15
3 Amp	1.65	35 Amp.	5.50
5 Amp	1.65	65 Amp.	11.00
10 Amp	2 00	200 Amp	50 00

Air Compressors For Dental and Laboratory Use

Complete automatic unit mounted on tank, "V" belt driven by heavy duty motor, with gauge, safety valve, check valve, drainer, etc Delivers about 1¼ cu ft. air per minute Clean air Can be used for all applications up to 70 lb.
Price . . **$39.50**
(Above unit $39.50 Others to $95 00)

Minneapolis Geared Motors

A C 110 volt input (18 volt output 10 ampere incorporated relay switch for controlling secondary equipment) Runs at about 4 R P M double arm with manual "on" and "off" control Will turn 180° at each contact Also has built-in transformer Reversible

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Made for the U S. Navy
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FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H P	R P M	CU FT. MIN	INLET	OUTLET	PRICE
0	1/20	1750	160	4½"	3¾"	$20 00
0½	1/8	1750	850	6½"	8¾"	22 50
1	1/6	1750	535	6 "	4½"	28 50
1¼	1/4	1750	950	7½"	6 "	85 00
1½	1/3	1750	1900	9½"	7 "	75.00

PRICES QUOTED ARE FOR A C. 110 V. 60 CYCLES ONLY.
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Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

SOLDERING

Stand Holds Iron And Magnifier

Rapid soldering operations on small parts can be carried on efficiently with a new soldering-iron stand produced by the Photobell Corporation and illustrated in one of our photographs. The soldering iron is held in an adjustable clamp, the 30-inch pipe acting as a chimney to carry off fumes. The hood is for the protection of the workmen and is provided with a magnifying glass of two, four, or six power or with ¼ inch plate glass, as desired. Under the hood are two lamps which illuminate the work.

Fumes are carried off

In use the operator holds the work against the tip of the iron with one hand while solder is applied with the other, progress being watched through the lens.

INSULATION

Panels Can be Nailed To Ceilings, Walls

Acoustic material in 12 by 12 inch or 12 by 24 inch plates is now available for application by nailing to flat surfaces. Produced in three standard thicknesses, the new material, known as Cushiontone, presents a smooth surface that can be cleaned with a vacuum machine or with ordinary wallpaper cleaner when it becomes soiled. It is claimed that it can be painted without loss of acoustical properties and that its characteristics include glare-free light reflection, heat insulation, moisture resistance, and light weight.

MARKER

Hand Operated Press For Nameplates, Badges, Parts

Nameplates, tool checks, badges, metal or fiber tags, small production parts, and so on can be rapidly and economically marked with a new hand-operated marking tool recently placed on the market by the Acromark Corporation. Guide pins and holes in the table of this press-type machine are provided to locate work pieces accurately A rack and pinion arrangement provide a leverage of 50 to 1 between handle and work.

POWDER METALLURGY

Reduces Machining Time, Releases Other Tools

The use of "powder metallurgy" to manufacture many metal parts ordinarily made by casting and machining, forging, stamping, and so on, is one important way in which industry can save machining time and release valuable machine tools for other work, according to an article by Fred P. Peters, in a symposium on "faster production" published in *"Metals and Alloys."*

"This production method—the molding of parts to finished dimensions by pressing metal powders in dies and then heat treating—has only recently risen to prominence as another (and often faster or better) way of making certain metal parts," he says.

"Powder metallurgy presses are available that can produce small parts at rates up to 500 per minute, although production rates are normally between 25 and 150 per minute. In one plant 10 million flanged bushings a year are being produced by powder metallurgy at costs that compare with those for similar pieces made from flat strip stock."

Nevertheless, Mr. Peters warns that powder metallurgy is no panacea and has numerous limitations. "The fastest metal-part production is probably obtainable by die casting, the closest tolerances through screw-machining.

"Powder metallurgy involves the least waste of material, but its tool costs are likely to be among the highest. A process like cold-heading and forming may provide a better all 'round combination of low tool cost, high production rate, low material-cost, and design flexibility."

HAND CREAM

Invisible "Gloves"

Protect and Heal

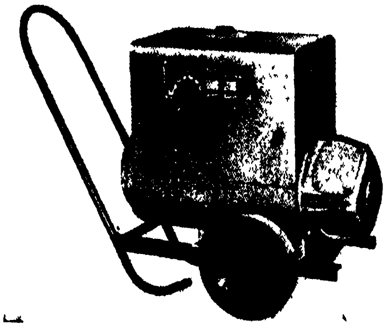
A NEW water-soluble hand cream that is applied to the skin before starting work guards the hands of workmen from grease, paint, ink, and other materials which are ordinarily difficult to remove. Known as Mitts, this cream washes off easily with soap and water, taking all dirt with it.

According to the manufacturers, one of the ingredients of this cream exerts a therapeutic action, helping to heal cuts and sores during the time the cream is in contact with the skin.

ARC WELDER

For Use on Thin-Gage Metal

FOR use in fabricating bright-surfaced, thin-gage metals, such as aircraft tubing (SAE-4130) which has a wall thickness of 35 mils, a new 150-ampere direct-current arc welder, the Strikeasy, has been



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A-4	Amp	Hrs	150	Ea	$5.50
A-6	"	"	225.	"	5.50
A-7	"	"	262	"	7.00
A-8	"	"	300	"	7.00
A-10	"	"	375	"	8.00
A-12	"	"	450	"	12.50
B-4	"	"	75	"	4.00
B-2(J-3)	"	"	37	"	5.50
M-8	"	"	11	"	2.00
L-20	"	"	13	"	2.50
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All cells 1 2 volts each

Above prices are per unit cell For 6 volt system use 5 cells 12 vt – 10 cells, 110 vt —88 cells Note On all cells 75 amps or less an additional charge of 10% is to be added for trays.

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Makes written record of code on paper tape Ideal machine for learning code or teaching code to groups Radio men can easily adapt it to short-wave receivers for taking permanent records of code messages Double pen permits simultaneous recording of two messages Pens operated by battery and key while tape feeder is spring driven Made of solid brass on heavy iron base Useful on fire, burglar alarm and watchman systems May be used to intercept telephone dial calls 10 ohms

Rebuilt & finished like new **$47.50** Reconditioned **$30.**

U S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts **$1.95**

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate Exceptional value **$1.95**

Anti-Capacity Switches

Made by Western Electric Double throw switch with 12 terminals - equivalent to two double-pole, double-throw switches All contacts are of platinum plate Original price $3 50 each Shp Wt 1 lb Your Price **$1.50**

U. S. ARMY TELEGRAPH SET

Signal Corps telegraph key and sounder mounted on mahogany board Operates on 2 dry cells **$5.95**

TELEPHONE SWITCH DIALS

"Kellogg" 4 terminals, 10 digits Diameter 2⅞", new .. **$3.50**

GLASS MERCURY TUBE SWITCHES

3 amp	$1.25	10 amp	$2.25
6 amp	1.95	20 amp	2.95

U. S. Navy Divers Lantern

Electric 150 watt, any voltage, solid cast brass 300 lb test Weight 12 lb Price **$8.50**

"Veedor-Root" Revolution Counter

Six number, (999999) non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special **$7.50**

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Gasoline Driven "Delco" 1000 watts, 120 volt direct current generator Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery ignition. Weight 340 lbs

Price . **$200.00**

Additional data on request.

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Ward-Leonard Vitrohm, Capacity 15 amp max, 5 amp min Res 6 ohms **$7.50**

Other sizes in stock

DYNAMOTORS D. C. to D. C.

24-750 volt, Gen Electric 200 mills . $27 50

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12-350 volt 80 mills $18.00
12-750 volt 200 mills . . . 30 00
32-350 volt 80 mills . 9 00
32-300 volt 60 mills . 7.50
Dynamotor armatures, General Electric triple commutators, d c 24/1500 volt . 12.50

CONDENSERS, MICA, operating volts 12,500, cap. 004

Dubilier, new $12 50
Dubilier used $7.50
Wireless spec new $10.00
Wireless spec used $7 50

Condenser Dubilier, mica, op volts 8,500, cap 004 ... $7.50
Condensers, Murdock 022 mfd 5,000 volt .. $2.00

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Copper plated capacity 002 operating volts, 12,500 Height 14", diameter 4½" Price **$4.50**

U. S. Army Parabolic Searchlight Mirror Precision Quality

DIA	FOCAL LENGTH	GLASS THICKNESS	PRICE
11 in	4 in	¼ in	$15.
18 in	7⅞ in	5/16 in	35.
30 in	12½ in	7/16 in.	75.
36 in	18¼ in.	7/16 in	125.

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A few 60 in. slightly used metal mirrors on hand.

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Electric Eye relay, assembled ready for use on 115 volts A C. as illustrated. Handsome black base 3x5". Relay contacts spdt, 3 amperes, 115 volts Highly sensitive, operates on flashlight, daylight, etc. Money back guarantee.

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announced by the General Electric Company. The design and characteristics of the new welder have been developed to help operators produce strong, uniform joints quickly and easily without spoilage.

Chief among the features of the Strikeasy arc welder is its "pep" or extra high instantaneous recovery of voltage (40 to 60 volts) which helps the operator to strike the arc with ease under the difficulties presented by thin metals having a bright, polished surface. The wide welding range permits the use of shielded-arc electrodes as large as 3/16 of an inch in diameter and as small as 3/64 of an inch.

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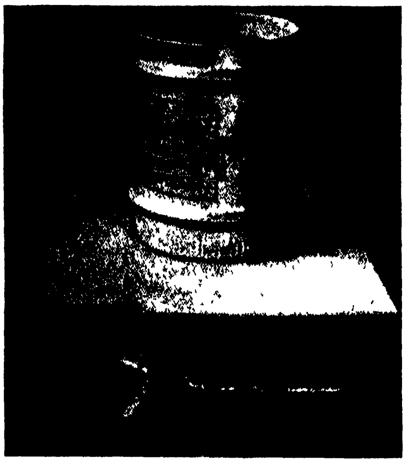
PACKING

Compacting Device For Settling Bulk Material

Operated by water pressure at approximately 50 pounds per square inch, a device is now available for settling light, powdered material in bulk containers. Materials such as soap chips, aluminum powder, and so on require this settling and compacting action in order to conserve space in containers.



Material Jolter

This new device, produced by the Syntron Company, is so arranged that the frequency and amount of lift can be readily controlled. The container of material is placed on the platform and a valve is operated. A cylinder then lifts the plate and drops it sharply about once a second. The equipment is available in a range of sizes and can be provided with a motor-driven pump to operate a closed hydraulic circuit.

MASKS

For Workmen, Use Plastic Pieces

Plastics are now being used in the construction of masks through which workmen may breathe without inhaling irritants suspended in the atmosphere. Made of shatterproof tenite, a plastic piece on each side of the respirator holds a felt filter which cleanses the air. It is lighter in weight and better in appearance than the aluminum part formerly used, according to the manufacturer.

Light-weight plastic side pieces are used in the respirator being worn by this spray-gun operator

The mask can be used in mines, breakers, granaries, and other places where dust threatens the health of workers. Painters using spray guns may also wear the device to protect themselves against fine particles of suspended paint. Air exhaled through the mask does not pass back through the tenite-held filter but it released by a valve in front of the respirator. The valve automatically closes when the wearer inhales.

The replacement of aluminum by tenite has lowered both labor and materials costs. The tenite parts come from the mold ready for assembly. They are molded by a process which turns out finished articles at the fastest speeds ever attained with plastics.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below)

CAA for Defense is a 16-page pamphlet on the work of the Civil Aeronautics Administration in civilian pilot training, airports, and airways, all aiming toward national defense and future peacetime safety and efficiency. Illustrated with photographs and charts. *Department of Commerce, Civil Aeronautics Administration, Washington, D. C.—Gratis.*

Minerals Yearbook is a 1459-page authoritative reference work covering the whole broad field of minerals. Production, stocks, distribution, and consumption of metals, nonmetals, fuels, and mineral products are covered in a comprehensive manner with a large array of data. *Superintendent of Documents, Washington, D. C.—$2.00.*

Elastic Stop Self-Locking Nuts is a four-page folder describing a relatively new type of lock nut and its various uses in a wide range of equipment where safe, vibration-proof fastenings are needed. *Elastic Stop Nut Corporation, 2330 Vauxhall Road, Union, New Jersey.—Gratis.*

The Caterpillar Condensed Catalog is a 36-page booklet, in two colors, devoted to track-type tractors, road machinery, Diesel engines, and so on. Each of the products is illustrated and brief specifications are given. Request Form 6425. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

The Observer's Handbook For 1942 contains data on the planets and other astronomical phenomena, month by month; also lists of double and multiple stars, variables, four star maps, an ephemeris of the Sun, and miscellaneous astronomical data to the extent of 80 very useful, practical pages. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada.—25 cents.*

Survey of Roofing Materials, by H. R. Snoke and L. J. Waldron, presents data on the weathering qualities and extent of use of various types of roofing materials on dwellings in the north-central states. 48 photographs illustrate the text. Request Report BMS75. *Superintendent of Documents, Washington, D. C.—15 cents.*

Structural Plastics in the Aviation Industry, by J. B. Johnson, is a copy of a paper, presented before the Society of the Plastics Industry, which surveys the various uses to which plastics are put in the construction of aircraft. Tables and drawings cover mechanical properties of plastics, tensile properties under varying temperatures, shear tests, and so on. *Society of the Plastics Industry, 295 Madison Avenue, New York, New York.—$1.00.*

Precision Instruments for the Exacting Inspection of Internal Surfaces is a 12-page catalog describing and illustrating a series of industrial telescopes which are now finding wide use because of the increasing importance of visual inspection of internal surfaces, recesses, and hidden contours which cannot ordinarily be seen. *American Cystoscope Makers, Inc., 1241 Lafayette Avenue, New York, New York.—Gratis.*

Photography as a Vocation, by Andrew B. Hecht and George J. Berkowitz, is a 48-page paper-covered booklet which tells how the serious minded and talented camera hobbyist can prepare himself for a career in photography. Various photographic occupations are analyzed in a simple yet comprehensive manner. *Science Research Associates, 1700 Prairie Avenue, Chicago, Illinois.—50 cents.*

The Story of Vitamin A Esters is a descriptive pamphlet covering the process of molecular distillation whereby it is possible to produce concentrated vitamin products of high stability from fish oils. *Distillation Products, Inc, 755 Ridge Road West, Rochester, New York.—Gratis.*

Performance of Pressure-Type Oil Burners, by M. P. Cleghorn and R. J. Helfinstine, is a 32-page report of tests conducted primarily to provide information of assistance in the intelligent selection and operation of oil burners. Included is a tabulation of relative heating costs with coal and with oil. Request Bulletin 151. *The Director, Iowa Engineering Experiment Station, Ames, Iowa.—Gratis.*

A Great Team is a four-page illustrated circular that describes a new radio transmitter and receiver specifically designed for use by private fliers. The units are light in weight yet high in power and performance. *Lear Avia, Inc., Dayton, Ohio.—Gratis.*

Walker-Turner Machine Tools is a 56-page catalog illustrating and describing a standard line of metal-working and wood-working machine tools of all types. *Walker-Turner Company, Inc., Plainfield, New Jersey.—Gratis.*

Tooling Turret Lathes for Small Lot Production is a four-page folder describing the use of Kennametal steel-cutting carbide tools for this particular purpose. Desirable economies are claimed. *McKenna Metals Company, 1000 Lloyd Avenue, Latrobe, Pennsylvania.—Gratis.*

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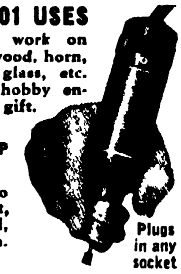

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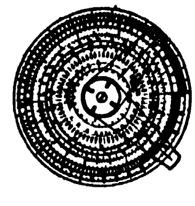

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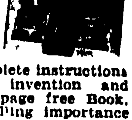

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AVIATION

Molded Plywood Planes

Plastics Plus Multi-Layered Veneer Used in Construction of New Two-Engined Ship

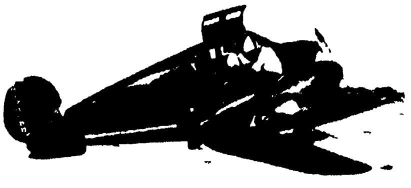
ALEXANDER KLEMIN

Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim School of Aeronautics, New York University

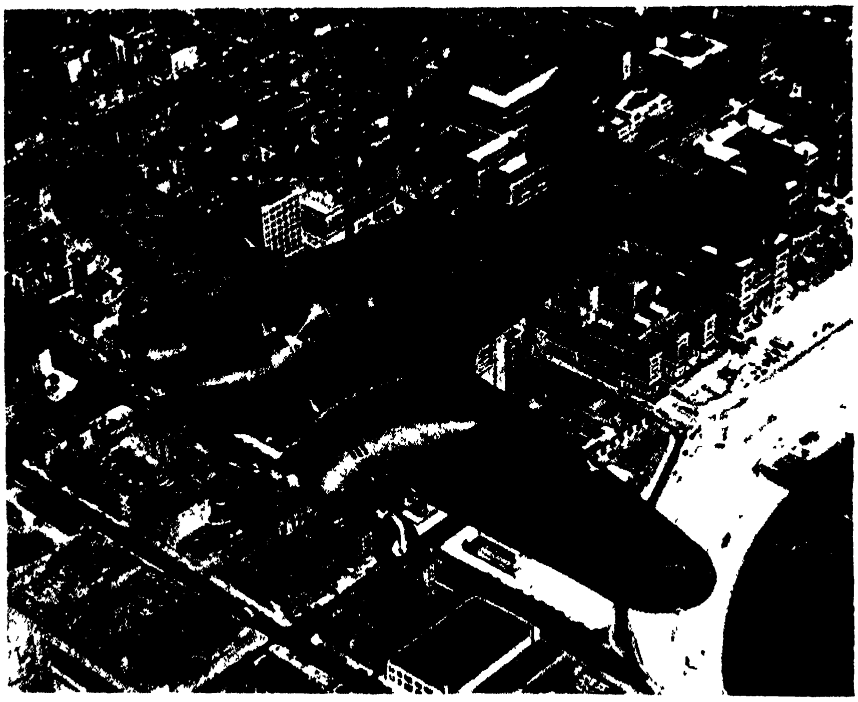
A SMALL, twin-engined plane, the Langley, has attracted favorable attention by its looks and performance. But, and this is more important, the new plane is built entirely of molded plastic-treated plywood by a process which helps the aluminum shortage and which lends itself to mass-production methods. Since the exact methods employed by the manufacturers of the Langley plane are not entirely available for publication, we shall quote verbatim from the maker's description, with the sole comment that the process is known to us as really effective:

"The molded plastic plywood parts of the Langley ship are multiple layers of veneer, formed over a mold and permanently bonded together into a completed structure by plastic compositions which react in their characteristic manner to heat and pressure. Each of the integral members—fuselage, wings, control surfaces, and cowling—are joined together without any mechanical fastenings such as nuts, bolts, or screws. In place of mechanical dies, the Langley parts are made on relatively simple wooden forms or molds, prefabricated strips of veneer being placed over each other upon the forms while dry" Parts as big as half a fuselage are thus produced in one hour or less, under applied pressure and temperature. Cowls and fire walls are molded with an integral asbestos lining.

Simplicity of construction, resistance to corrosion and to temperature effects are features of the plywood plane. Real possibilities appear. With two 65-horsepower Franklin engines, and a gross weight of 2300 pounds, top speed is 142 miles per hour, ceiling is 15,000 feet and take-off distance is only 200 feet. The Langley should



The plywood plane with hatch open and, *below*, ship in the air



be a very useful training plane for pilots who are to fly fast twin-engined ships later.

Heading up the Langley Corporation is Caleb S. Bragg, an old war-time pilot. Working vice-presidents are Messrs. Draper and Jensen, with Smithline, a graduate of the Daniel Guggenheim School of Aeronautics of New York University, as the technical man of the group.

AIRPLANE ARMOR

Welding Produces Intricate Curved Sections

THERE are two types of armor plates, one known as face-hardened or carburized, in which carbon is added on one side of the plate for about a quarter of the thickness and the face becomes hard and capable of resisting even armor-piercing shells. The other type, called homogeneous armor plate, is uniformly hard throughout but is not so resistant to shell fire as the face-hardened type. Breeze Corporations inform us of an advance in the hitherto costly and tedious process of carburizing armor plate.

Three pieces of airplane armor

In the older process, the steel plates to be carburized are placed in metal boxes packed with carbon dust and wait for many hours before the heated steel can absorb the carbon on the chosen side. In the new Breeze process the plates are placed in large pots filled with liquid salts, heated electrically and accurately controlled. The result is closer control, more rapid and more uniform carburizing.

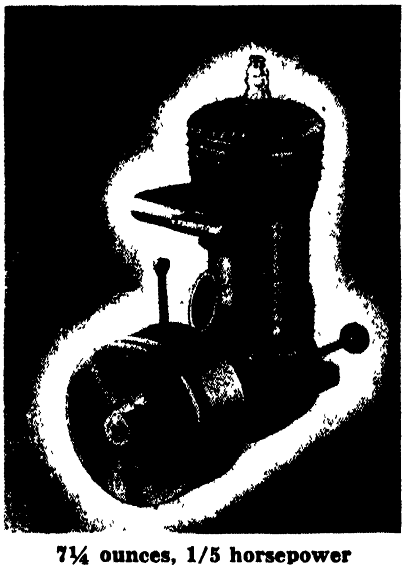
Another process which the ingenious Breeze engineers have developed is one of welding the finished armor plate together, making it possible to produce intricate curved sections such as, for example, the section of armor plate for shielding the pilot, is shown in one of our photographs. It looks like a small bathtub into which the pilot's seat is fitted. Other sections shown are gunner front shield in the center, and fighter pilot shield to the right.—*A. K.*

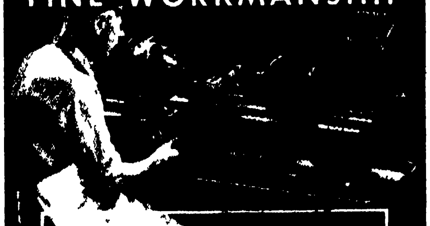
MIDGET ENGINE

For Gasoline-Powered Model Planes

THOUSANDS of American boys fly rubber-driven airplane models and do wonders with the primitive power plant of a few strands of rubber. Eventually they graduate to gas-driven models, and then the young engineers surpass themselves. Of course, even the most mechanical lad can hardly expect to build a perfect, tiny gasoline engine to power his model. That is where Aircraft Industries, Inc., help him out with a tiny "Super Cyclone Engine," which in its way is as fine as the giant Cyclones built by the Wright Aeronautical Corporation.

One of our photographs shows one of these fine little units, which operate splendidly without too much care by the boy engineers, and which are designed to stand a good deal of abuse since the models land themselves, at times, very roughly The specifications are complete and thorough Two-port, two-cycle, air-cooled Fuel admission through rotary crank valve, Normal horsepower 1/4 to 1/5 Bore 15/16, stroke 15/16 Weight bare only 7¼ ounces. Propeller 13 inches diameter, revolving at between 6000 and 7000 revolutions per minute —*A K.*


7¼ ounces, 1/5 horsepower



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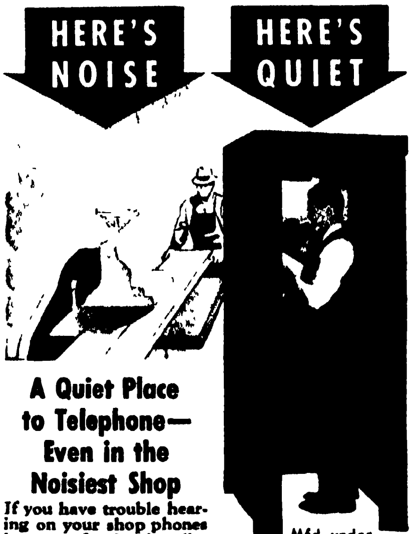

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The Professional On Portraiture

THE work of the professional portrait photographer is, in too many instances, so humdrum and lacking in imagination that when we have the opportunity of meeting one who still retains his amateur enthusiasm and a consciousness of fine technique, we never fail to listen. One such photographer is Maurice Carnes LaClaire, whose exhibition of portraits made with the Contax recently attracted wide interest at the galleries of Carl Zeiss, Inc., in New York City.

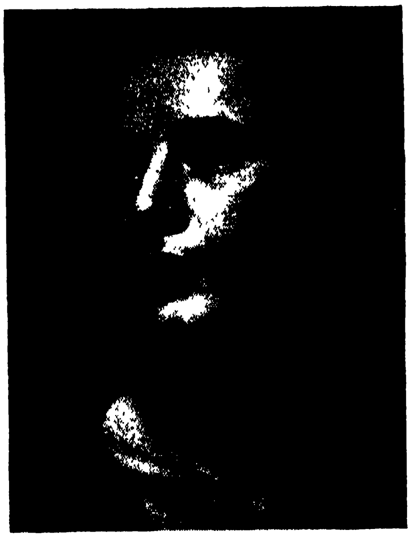
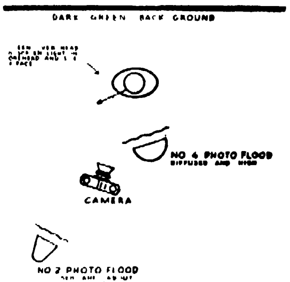


Figure 1



We reproduce three examples from the show, together with lighting diagrams. Discussing Figure 1, Mr. LaClaire said that while the general rules for portrait lightings hold good for the average subject, it is sometimes advisable, and even necessary, to disregard accepted rules. Therefore, instead of using a broad lighting effect with this subject, he deliberately used a top front light which, he felt, brought out and emphasized the planes of the woman's face.

"This young lady has very small eyes," he continued. "Illuminated by the conventional 45-degree side light they appear very narrow and lack expression. By using the top light well forward, emphasizing all the planes of the face very strongly and by using the low point of view for the camera I have succeeded in giving this subject both dignity and expression. The subject has a mixture of large and small features which, taken from the normal viewpoint, would bring out none of that which is best pictorially, but these very features are *made* to dominate and carry the eye about in the picture area. Notice that the whole action of the head is carried out from the lines of the neck to the direction of the eyes."

The lighting arrangement is shown in the diagram. The No. 4 Photoflood is diffused with one thickness of tracing cloth placed near the camera and well above the subject. To soften the light on the forehead, a small screen was used. For illuminating the shadows, the No. 2 bulb was placed well back and close to the floor.

Figure 2 is one of the most difficult, yet among the most characteristic and agreeable shots in the baby photographer's repertoire. The problem lies in keeping the lighting general and soft, at the same time balancing the artificial light with the daylight illumination coming through the window.

"This picture was made in the nursery and was illuminated in such a way that the light, while ample, was not a hardship on the tiny eyes," Mr. LaClaire explains. "With a fast lens and the fast film available nowadays, it is possible to make excellent portraits with a very small volume of light. In this instance a No. 4 Photoflood was turned directly up so that the undiffused light struck the ceiling and filled the room with light. This gave an excellent and very soft gen-

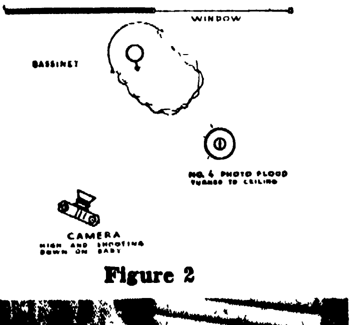
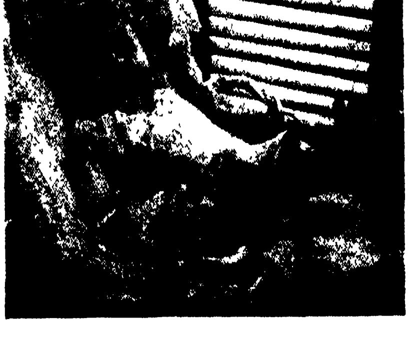


Figure 2



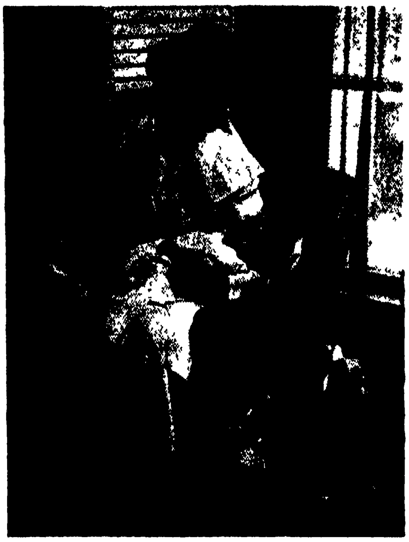
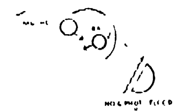


Figure 3



eral illumination. As you will note, the bassinet was placed close to the window and the accent light comes from the window, no other illumination being used."

An example of group portraits in the home is shown in Figure 3. The picture was made in a very small apartment. To prevent a black void in back of the subjects and to keep the tones of the picture harmonious, Mr. LaClaire used a light folding screen beside the window.

Mr. LaClaire suggests that should you have trouble having the mother hold the baby comfortably, you will find it helpful to crowd a small cushion or two between her elbow and the chair, this also helps support the weight of the child's head.

"Keep the light out of their eyes as much as possible," he advises baby photographers. "If they are lying down, have the light at such an angle that their eyelids shade their eyes, and by no means, when the baby is brought into the room, have the light turned on full. Reflect it against the opposite wall, gradually turning it so that the strength of it falls on the baby after his eyes have become accustomed to the more intense light.

"You will notice that while the window is in the picture, it is supplying none of the light that makes the picture. Had the light from the window been too strong, it would have outlined very disagreeably the baby's bald head and thrown too strong a light on the mother's face and far too much on the toys. And, speaking of the toys, I wish you to note that they are a number of shades lower in tone than the area surrounding the baby."

The lighting arrangement, as shown in the diagram, consists of a No. 4 Photoflood, diffused with one thickness of tracing cloth, in front and slightly to the right, and a No. 2 bulb in a clamp light fastened to the leg of a chair and some distance from the subjects.

Professional Aid

The Professional Photographers' Association of Connecticut, in line with a newly formed policy to "bury the hatchet" and get together with amateurs "in an all-out movement for the advancement of photography," recently voted to offer, through the camera clubs of the state, a loving cup to be known as the "Professional Photographers' Cup, 1942." Other aids are part of the general program, including availability of the association's various departments to the amateur clubs in the state.

Scholastic Awards

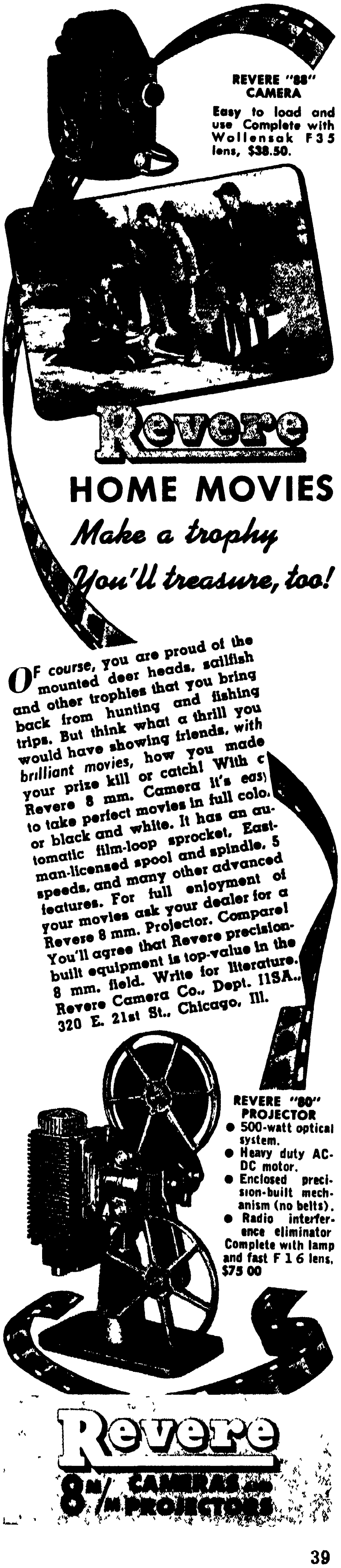
The Kalart Company announces its co-sponsorship, with *Scholastic Magazine*, of a nationwide competition among high-school students. This national magazine, the largest of its kind in this country, is used as a text in 8000 senior high schools. In connection with a division of photography, Scholastic awards have been made for 17 years The 18th Annual Scholastic Awards, to be announced soon, will include a special Kalart Award "for the best pictures taken by high school students, using a synchronized flash."

New Reflector Material

Designed for purposes of home insulation, a new material called Metallation, now on the market, is incidentally a very fine reflector for photographic use. The material is a composition similar to foil and is mounted on a thin but fairly stiff paper, which permits rolling up. One side is glossy, the other less glossy, almost semi-matt, thereby offering a double-purpose reflector, providing either the directional, strong reflection of the one, or the more diffuse reflection of the other. Bending the reflector in various ways will afford a selection of reflection angles. The material need not be mounted on a stiff cardboard but may be used as is, fixing the shape as circumstances dictate. The material is 25 inches wide and, in the quantity needed, very inexpensive.

Props for Effect

Famous for his original ideas in portrait and fashion photography, George Platt Lynes is also notorious for collecting odds and ends of apparently nothing at all, for possible future use in out-of-the-ordinary portraiture. An example is the reproduction of a portrait he made of the ballet dancer,



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BOOKS——BOOKS

Photo by George Platt Lynes

Tamara Toumanova

Tamara Toumanova. During a visit to Chinatown one day he noticed some Chinese painted kites on display, and purchased a few. These came in handy when he was arranging a shot of the dancer. One of the kites he pinned on the subject and a few others were pinned on a stretched white cloth behind her. The stretched cloth was then lighted from behind to give a luminous quality to the background.

Movie of Color Process

A 16mm motion picture film demonstrating, step by step, the processing of a color print by the Iso-Color Process, has been produced by the makers of the process, the Spectrum Products Co., Inc. This company offers to lend the film to camera clubs without charge. The film demonstrates how a color print can be obtained from a set of Kodachrome separation negatives in 40 minutes.

"Because there are only nine simple steps to the Iso-Color Process," says the announcement, "and because of its simplicity. . . it is possible for the first time to show the entire development of a color print in a film running only 15 minutes."

Guide Numbers

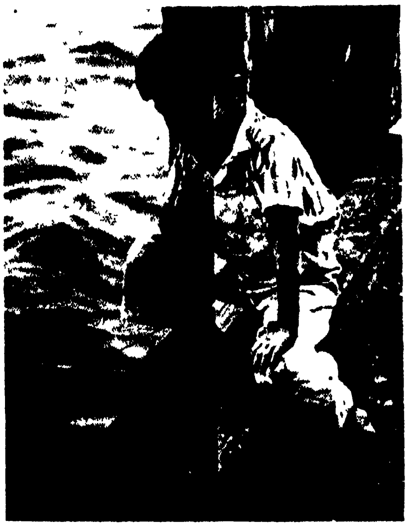
THE new system of exposure with Photoflash and Photoflood lamps, by which flash and flood bulbs of various sizes are assigned numbers for use as bases in determining the proper f/ stop to use, is one of the greatest conveniences to come the amateur's way in a long while. The system is simplicity itself, but since there are some who seem a bit puzzled, let us review it briefly here.

Guide numbers are assigned to individual bulbs according to the speed of the film being used (Weston or other film rating) and the shutter speed to be employed. The distance in feet of the lamp from the subject is then divided into the guide number, the result furnishing the f/ stop at which the diaphragm is to be set. Let us take a specific example. The Guide Number for a certain bulb at a given shutter speed is 160; the distance from lamp to subject is 10 feet. Divide 160 by 10—result 16, the f/ stop to be used. Could anything be simpler?

The system is now being applied to flood bulbs as well, but manufacturers generally recommend that exposure meters be used where possible.

New Tone Treatment

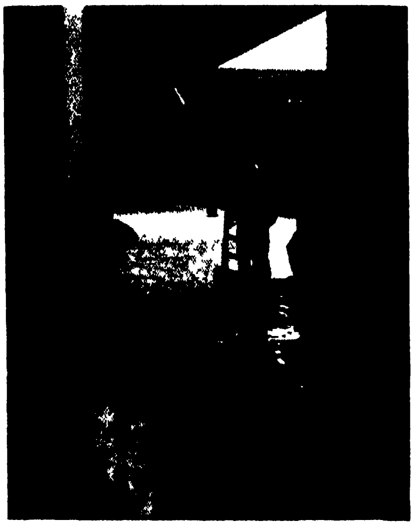
A NEW corrective treatment for negatives, prints, film and glass positives, and so on, is introduced in Supertone Clarifier, a two-solution formula designed to improve the quality of photographic images. The formula includes, in addition to the Clarifier, the Supertone Fixing Solution, and works equally well whether local or general treatment is desired. A few seconds immersion in the Clarifier is generally sufficient to effect the characteristic action of the treatment, that is, to remove a thin veil of metallic silver density from the image, thereby rendering it more brilliant. Softness may also be obtained, if desired. The typical action of the solution is demonstrated in the illustration, which shows a print after half of it was treated with the Clarifier.



Untreated and treated

Entry Forbidden

AS YOU can readily see, the figure in the left foreground is both a blessing and a curse so far as good composition is concerned in this particular print. It helps arrangement by lending weight to the left part of the picture, thereby materially aiding balance of the several elements. Unfortunately, however, because of the distinctness of the man's face and hands and the fact that he is staring directly at the camera, attention is diverted, though temporarily, from the main object, which is the man wheeling the truck into the light. Entry of the eye into the picture is



"Morning Sunlight"

therefore done hesitatingly because it is stopped by the prominence of the figure in the foreground. The thing to have done, of course, was to have waited until the man had turned his face profile. In addition, it would still be necessary in printing to do some dodging to cut the tone of the hands and face, as well as that of the packing box on which the man is seated.

Military Uses of Photography

Several of the most important uses of photography in the Army were recently outlined by Colonel M. E Gillette, Commanding Officer, Signal Corps, Fort Monmouth, before the Westinghouse Photographic Lighting Conference in Bloomfield, New Jersey. These included:

As an aid in military operations Pictures from the air are made during reconnaissance flights and are used to study military operations where maps are inadequate and where ground crews cannot go

As an aid to military training. Instruction by means of motion pictures saves a great deal of time and is much more effective than any other method.

In engineering work By means of pictures, both still and moving, the Army learns what happens to equipment during tests.

Supplying news pictures to newspapers, magazines and other publications.

For record or historical purposes

• • •

WHAT'S NEW

In Photographic Equipment

King Slide File Boxes (100-slide capacity, $2.50; 200, $4.50): For storing 2-by-2-inch color slides. Two sizes, one holding 100 slides, the other 200 slides. Finished in imitation leather. French lapped rounded corners add strength.

Maskoid (2-oz. bottle, 85 cents; 4-oz., $1.55): New-type frisket for multiple toning and other uses. Called "the liquid mask"; of pre-vulcanized rubber composition (not rubber cement) dries quickly after application. Forms temporary protective film for local work in coloring, retouching, bleaching, and so on. May be applied with pen or brush, or sprayed on with airbrush. May be removed by stripping from surface. Thins with water; dyes and acids will not penetrate it.

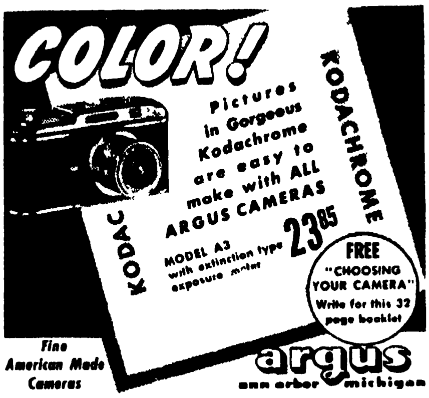
Lewis Multiple Slide Viewer ($3 25)· Loads up to 36 color slides at one time for continuous, uninterrupted viewing. Shifting of lever changes slides. High power plano-convex lens. Viewer fits over both eyes, excluding outside light except through transparency. One screw adjustment changes for either ready-mounts or glass slides. Made of wood and solid black fiber covered with black leatherette

Lewis Bulk Film Loader ($2.20) For loading bulk 35mm film. Darkroom needed only to transfer film from original wrapping. Cartridges wound by daylight. Loads for any number of exposures and holds up to 100 feet of film. Made of solid black fiber, leatherette covered. Holds two extra cartridges Winding directions gold-stamped on lid

Amateur Press Photographer's Outfit. Flash-camera outfit including. Agfa Cadet-Flash camera; flash unit with reflector; eight Mazda Photoflash lamps; adapter for lamps; two No 915 Eveready batteries; two rolls Agfa 8 (127) Superpan Press film. Camera has fixed-focus lens Flash unit easily attached to or detached from camera. Shutter automatically synchronized with flash mechanism

Signal (16-oz bottle, 45 cents). Called the "indicating" shortstop. Colorless when fresh, turns rose-red when exhausted. Signal (undiluted) may be substituted for 28 percent acetic acid in same proportion as called for in regular photographic solution. Each pint bottle makes 20 one-pint baths

Lyons Speed Graphic Case ($19.50). Designed for the 4-by-5 Speed Graphic, to accommodate the camera, 12 holders, complete flash outfit, and extension flash unit. Special compartment in top of case for storing flash bulbs. Case can be carried by means of shoulder strap with bulb compartment open. Made of plywood, covered with black leatherette. Nickel finished hardware. Case measures 17½ by 8¾ by 13½ inches Weighs 8 pounds, 12 ounces



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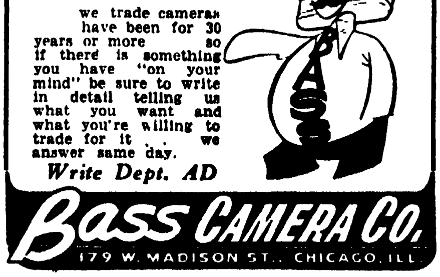

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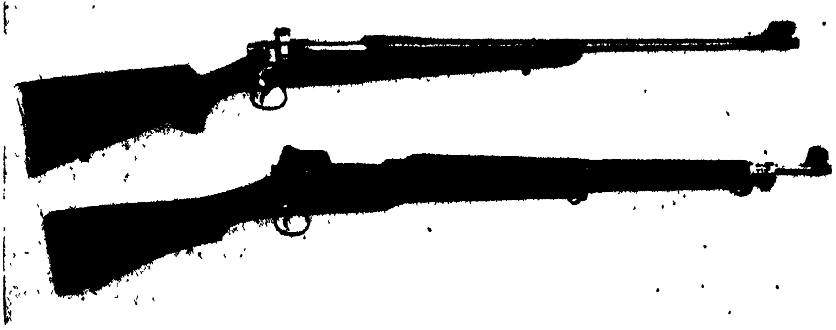
A Tyro Stocks a Rifle

Harry A. Groesbeck, Jr.

A FEW years ago I picked up a copy of *The American Rifleman* and was intrigued with an article on the re-stocking of a .45-70 Springfield. I have been burning powder and fondling guns for more than 50 years; I have some skill with tools, for working both wood and metal, but will you believe me when I confess I had never even thought of combining my two pet avocations? When I consider my present day enthusiasm for amateur gunsmithing, it is hard for me to believe I am the same man who once gave away his entire gun collection, considered himself washed up.



Above: **Remodeled Enfield. Note front sight, fashioned from steel block; metal recessed buttplate.** *Below:* **A 1917 Enfield rifle, as originally issued**

The amateur gunsmithing job started simply enough, with a new front sight; then followed some polishing and refurbishing of a few old cap-and-ball hand-guns Harold F. Kent, of Lawrence, Massachusetts, is the man who really upset my peaceful apple-cart. He sent me a 1917 Enfield and dared me to re-stock it When the hardware arrived, it was a pretty sad-looking outfit Someone had already started to butcher it and I suppose it aroused my sympathy, especially as Kent sent with it a most complete description of how to proceed on such a job. (Remodeling Military Rifles—How to Transform a Military Rifle Into a Modern Sporter. Technical Bulletin 104, National Rifle Association.—Ed.)

After reading this useful little article, I blew myself to Clyde Baker's book on gunsmithing, which I read from cover to cover before starting on my venture. Then I sailed in.

I should enjoy writing a most detailed account of every move I made in completing this job, but it would serve no good purpose. I came to the job as an absolute tyro in this particular field and I simply followed the books—as a good novice should Did I say I followed the books? So I did, but I want to qualify that statement just a bit, because when I did *not* follow them, I sometimes found myself in hot water. It is about that punishment I feel I should write, lest others do as I did and then fail to have the good fortune that pulled me through

The lads who have been doing this sort of work all their lives, both as amateurs and professionals, know what they are talking about. They have written guides to be followed by others, and they have planned these instructions in such a manner as to save their readers no end of trouble Every time I got cocky and went off on some track of my own, I paid How many times this happened is my secret, but my worst offense was impatience Like all beginners, I yearned to see "how it would look."

When I shaped both the stock and the fore-end before thoroughly finishing the bedding-down of the action, I found I had nothing to hang on to while completing the work. I used more time finding a way to squirm out of that hole than the man who paints himself into a corner of his room. Anyhow, I finally finished the job, and despite my foolishness in some instances, the rifle came out well. The bedding-down is accurate, a full "blue" fit of wood to metal The lines follow those prescribed by the authorities, with but slight deviations of my own. The finish turned out beautifully—and that baby groups the shots on the target to beat the band!

Frankly, while I am proud of the

job, I seek neither publicity nor praise for the accomplishment. Rather. I tell the story to encourage others to go and do likewise, and I have many good reasons for so doing.

First, let me pay my little tribute to the National Rifle Association for, among other things, starting me off right. Then, consider how much one can learn of the most intimate "innerds" of firearms, if one has to reduce them to their individual components in order to work on them Also, there is the fun of doing it and the utilizing of some very worthwhile "junk" which, in these troubled times, may turn out to be priceless Finally, there will be the knowledge gained, to be passed on, perhaps, to some youngster who is facing the most serious times of his young career. Who knows but that a tip from some "old guy" who dabbles with guns, and who knows not only what to do with them, but what *not* to do, may stand some boy in good stead in a moment when things are happening fast. — (We've visited Harry Groesbeck's workshop in the basement of his home, seen his tools and equipment, and some of the rest of his accomplishments For those who like to work with wood and metal, but who have been fearful of entering the field of firearms tinkering, his is a most encouraging example, for his gunsmithing activities have been going on only three years Nevertheless, he is turning out masterly work, and at present is engaged in re-stocking an old Krag that saw service in the Philippine Insurrection of 1899. The gun was captured by Aguinaldo's native troops, later recaptured by Major Philip Eastwick, of our Army, and one day soon, dressed as a sporting rifle, it will demonstrate its inherent accuracy, doubtless enhanced by the work of the amateur gunsmith.—*Ed*)

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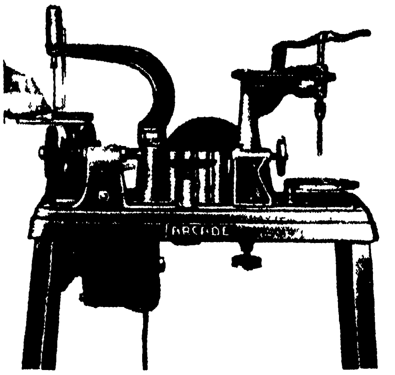

"The Craftmaster"

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Never intended as a target rifle, it is, nevertheless, an extremely popular gun among the army of deer hunters because of its accuracy, ease of operation, and speed of fire, especially in wooded country Another reason for this popularity is the similarity in general lines to the slide-action shotgun Save for an annual week or two, many deer hunters are otherwise shotgun devotees, and the swing of "The Gamemaster," as it comes to the shoulder, is less foreign than would be either a bolt- or lever-action rifle.

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By Committee on Work in Industry, National Research Council

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JUST what is the present status of the 200" telescope mirror that is being made in California? What troubles have been encountered in the work, and how have these been dealt with?

From time to time the newspapers have stated a few facts—and some fancies. Three long articles in Scientific American (May 1936, November 1936, August 1938) stated many precise facts because they were written by the men who are making the telescope. Yet, even these did not fully satisfy those of this magazine's readers who are amateur telescope makers. This 10,000-sized minority of readers has wanted special, technical details not watered down for the general, non-telescope making reader.

This column therefore invited Dr. J. A. Anderson, who has lived with the actual work throughout, to describe the mirror part of it specifically for the amateur telescope maker, and in the lingo of the work. This is why the article presented is published in this department and not "up front."

The following is the first half of a two-part article by Dr. J. A. Anderson who, since 1916, has been chief optical expert at the Mt. Wilson Observatory and, since the start of the 200" telescope work, executive officer for it at the California Institute of Technology where the great mirror is being made.

"THE 200-inch mirror disk was cast at the Corning Glass Works in March, 1935, and arrived at Pasadena in April, 1936. The structure of the disk is indicated by the oblique photograph reproduced in Figure 1, showing the back and rim, and the diagram, Figure 2, showing a section along the line *AA* of Figure 1. In general it may be described as a continuous glass front supported by a system of glass ribs, so designed that when a concave curve is cut in the front surface (shown by the dashed line in Figure 2), the thickness of the glass shall be nearly the same everywhere. This construction was chosen in order to reduce the 'temperature inertia'[1] of the disk as a whole to a low value. It also makes it possible to bring the point of support of each supporting lever close to the center of gravity of the weight to be supported. For this purpose there are 36 circular openings in the rib system to accommodate the same number of supporting levers. Figure 3 shows one of the supporting units which is 'double-acting'; that is, it takes the place of both the ordinary back and edge supports.

"The work of shaping this disk into a finished mirror is not essentially different from that required for a smaller mirror familiar to all amateur telescope makers. Front and back must be ground flat and parallel to each other, and the edge ground to the form of a reasonably good circular cylinder. In addition, the 200-inch required that the 36 circular openings for the supporting levers be ground internally to very definite dimensions. An important difference arises from the great size and weight of the 200-inch; namely, that machinery is called for at every turn—and rather heavy and slow moving machinery at that.

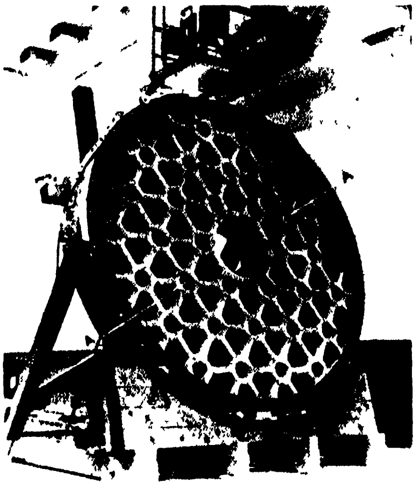

Figure 1: **Back of the big disk**

"For the rough shaping a half-sized tool of cast iron was prepared. Its weight was about seven tons. It was made thick enough to be used first as a flat grinder and later on to be turned convex for roughing out the concave curve of the mirror. All other tools, including one of full size, were built up of thin sheet-steel plates welded together. These are much lighter than cast tools of the same size and they have also been found to be superior in rigidity. The working surfaces of these tools are covered with glass blocks which are used uncovered for grinding and covered with pitch substitute for polishing. The weight of the full-sized tool (shown on the floor to the left in Figure 4) is about five tons.

"In order to grind the back surface to a tolerably good plane, it was necessary to fill up the openings between the ribs. Little wooden tables were made and fitted into these openings in such a way that the tops of the tables lacked about 2" of being flush with the ribs. Plaster of Paris was then used to complete the filling. Only in this way was it possible to grind the surface to a true plane. This done, the cavities were cleaned of plaster and tables and the disk turned over in preparation for the next step, which was to grind the face plane and parallel to the back.

"Normally, this should have required a relatively short time, but actually it took many months, chiefly for the following reason: Corning had a considerable flood in 1935 while this disk was in the annealing oven. Water covered the floor of the room where the annealing was in progress to such a depth that it was necessary to shut off the current for about three days. A temperature drop of rather large amount was the result, but as soon as conditions permitted the temperature was slowly brought up to its normal value and held there constant for a time. Then the regular program of slow cooling was resumed. When, in late October 1935, the disk was examined, it was found quite successfully annealed, but there were some bad-looking fractures in the front surface. The immediate cause of these fractures was clear, for a couple of the chrome-iron I-beams of the cover had sagged enough to become partly imbedded in the hot glass and, as the cooling proceeded, strains due to the differential expansion of iron and glass did the trick. One has a feeling that this would not have happened if there had been no interruption in the cooling but, of course, this can now

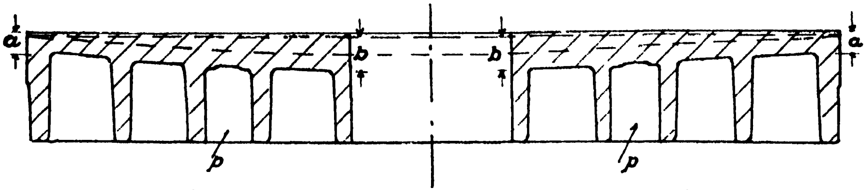

Figure 2: **Section along line *AA* in Figure 1. *p,p* are openings for supporting units. In the casting, thickness at *a,a* was 6", at *b,b* 9¾". In finished mirror (lower dashed line) thickness is approximately 4". Overall thickness at edge is 24". Finished weight, nearly 30,000 pounds**

never be known with full certainty.

---

[1] 'Temperature inertia' is a convenient term to indicate the length of time required for the temperature to reach equilibrium with the surroundings

"The obvious thing to do was done; namely, to remove the fractures by sand blast and so find out whether sufficient thickness of glass remained to make a good mirror. The deepest excavation made in the sandblasting was over 5" deep but it was near the center of the disk, so it would still be possible to grind the concave curve and have a glass thickness of 4" left. If the disk had come out as planned, this thickness could readily have been 6" or a little more, which might have been an advantage if rigidity alone is considered. A thickness of 4" is, however, slightly better from the point of view of low temperature inertia, since all the ribs have about this thickness.

"It was decided that, instead of merely making the front surface into a true plane, the extra 2" of glass should be ground off before establishing the plane and making the disk parallel. This 2" of glass represented a weight of 2½ tons and used up five tons of coarse Carborundum. Later on, another 2½ tons of glass would have to be removed in cutting the concave curve.

"Grinding the edge was the next operation. This was done face down, with the face of the mirror raised some 8" above the turntable by inserting suitable timbers The grinding was done with a rotating hollow cylinder of Carborundum fed with water and Carborundum powder. The 40" central hole was ground to size in this same set-up

"The next step was grinding the 36 cylindrical holes designed to admit the supporting levers The axes of these cylinders should be perpendicular to the parallel planes of the front and back already established, and, in addition, their spacing should be adjusted to form a regular geometrical pattern. A special 'pocket-grinder' had been prepared, carrying at its lower end a cast-iron hollow cylinder about 11" outside diameter. The rotating shaft carrying this cylinder could be given a slow motion in a circle having a radius variable slowly and accurately from nothing up to whatever the size required for the finished 'pocket'

"The 36 pockets lie on five concentric circles, six on each circle except the fourth one (counting out from the center), which has 12. On circles 1, 2, 3, and 5 they are 60 degrees apart, while on the fourth circle they are spaced in six pairs 60 degrees apart, the members of a pair being separated by an angle a little less than 22 degrees. The whole operation of grinding these pockets was completed in about three months.

"Next the turntable of the grinding machine was covered with two layers of 1" sponge rubber and the mirror placed face-up on this bedding. In order to insure as uniform a support as possible the compression of each

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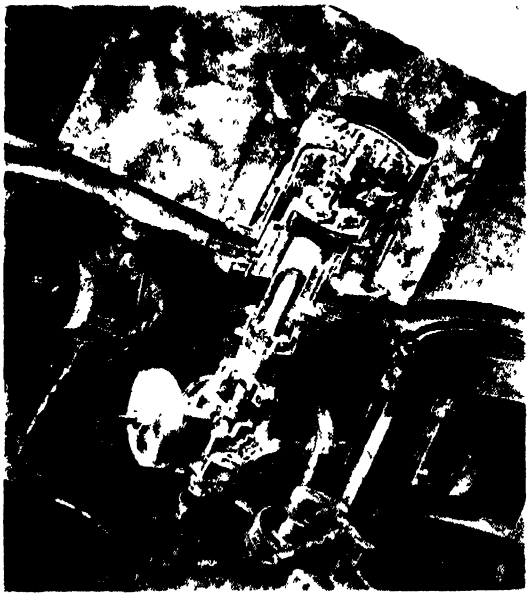

Figure 3: **Lever mirror support**

sheet of sponge rubber was carefully measured under a fixed load, and only those pieces whose compression was within a narrow range of being the same were applied to the table.

"The glass plug to fill up the 40" hole in the center of the mirror had been ground cylindrical to a suitable diameter, and it had to be inserted and fixed in place in such a way that, when the mirror is finished, it can be easily removed without any danger of harming the figure of the mirror. As the plug weighs about 1400 pounds, this did not look too easy. It was accomplished as follows: A wooden lifting clamp was applied to the upper half of the plug, leaving the lower ribbed section of about 15" projecting below the clamp. A cake of ice about a foot thick was placed on the table in the center of the hole. By means of the crane it was then possible to rest the plug on the cake of ice. The clamp was removed and the ice melted, thus lowering the plug gently into its proper position, after which it was fixed in place by means of plaster of Paris and waterproof cement.

"Before cutting the curve the support system was installed. This operation took approximately eight months. In preparation for it the weight to be carried by each of the 36 units had been calculated on the basis of careful measurements on the disk itself. Each support pocket was taken as the center of a hexagonal section of the disk. The hexagons around the central hole (Circle No. 1) and those adjoining the outer edge (Circle No. 5) are not complete, which fact complicated the calculations only slightly. The calculations furnished the weight to be carried by each unit and also located the center of gravity of each arbitrary section of the disk, thus giving the necessary data for each counterweight and for locating the internal points of application of the supporting force. Each support (Figure 3) was carefully adjusted and tested on a weight equal to that which it was intended to carry before it was attached to the mirror and its cell. Provision was made for temporarily disconnecting all the supports when work was in progress with large tools. They were, however, connected properly when an optical test was to be made.

"The curve was roughed out with cast-iron tools of about one third size, and brought to approximately correct form by means of the half-sized tool already mentioned, after which the glass-coated full-sized tool and the finer grades of Carborundum and emery finished the grinding. Measurements of curvature were made with a 36" spherometer. Next, the full-sized tool was changed to a polishing tool, as already explained, and the surface brought to a nearly full polish. It was found that the full-sized tool used up rouge at the rate of some 50 pounds per hour, mostly by simply splashing it over the edge, hence subsequent polishing and figuring was done with smaller tools—106" and down to about 12"."

Next month: Troubles. Tests This part will explain the delays that puzzled the public: the disk developed a case of curable ptosis.

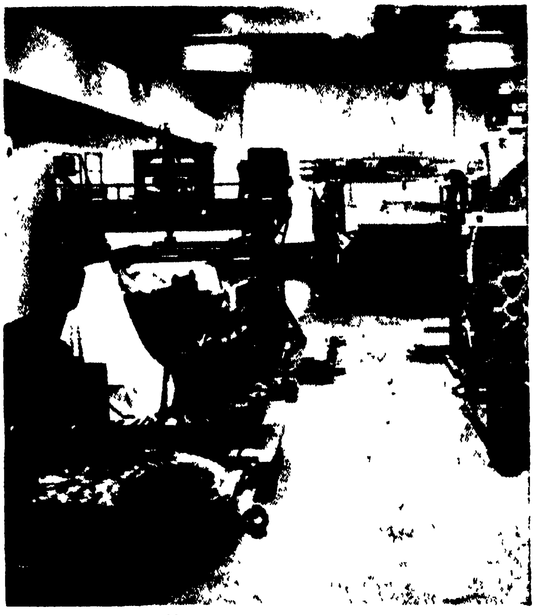

Figure 4: **Five-ton, full-sized steel tool. Grinding and polishing machine in rear**

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DEVELOPMENT of the destroyer in the navies of the world has been such that today no other fighting ship is depended upon to carry out so many varied tasks. The work of these versatile naval vessels is described in detail in the article starting on page 55.

●

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OUR Point OF VIEW

CIVILIAN DEFENSE

IN THE kind of war we are fighting today civilian protection is necessary because this is an "all-out" war, a "total" war, an "everybody's" war — and there's nothing new about it. It is as old as mankind. In fact, we have Mr. Schicklegruber's statement for it that one objective of this kind of a war is "the disappearance of the vanquished people from the stage of history." Accordingly, as everyone now knows, total warfare is waged not only against the armies and the navies and the air forces, but the civilian men and women as well, to say nothing of the children and the old people. That's why we must consider civilian protection. That's why we are faced with the necessity of perfecting organizations to minimize the effects of air-raid damage, to prevent hysteria, and above all to save civilian lives

To accomplish this, the United States Office of Civilian Defense was established by Executive Order on May 20, 1941. It was assigned the job of preparing and organizing a means of defense against the horrors of hostile attacks on the unarmed portion of the nation by air or otherwise. To this end Civilian Defense basically has been shaped up on a "neighbor-help-neighbor" policy—a volunteer program as broad as the United States itself and as American as Lexington's Minute Men.

Contrary to public opinion in many quarters, the Office of Civilian Defense had made remarkable progress prior to Sunday, December 7, 1941 Before the bombs fell on Pearl Harbor, too many of us were of the opinion that "it can't happen here," and as the growth of the many-sided plan depended entirely on volunteer action on the part of the people it was designed to protect, its efficiency was stultified After Pearl Harbor—who among us didn't ask the questions, "What can *I* do? Where do *I* fit in?"

The answer is simple The three broad categories of help in this war are Armed forces, productive forces, and civilian defense. The first needs no amplification. The second includes necessities of civil life such as groceries, clothing, and fuel, as well as planes, tanks, guns, and shells For the third, volunteers — thousands upon thousands of them — are needed in every community, whether large or small. There's room for everybody in Civilian Defense, and everybody is sorely needed, from doctors and nurses to file clerks and publicity experts, from dietitians to telegraphers; from air-raid wardens to sanitation experts. Ignorance of the requirements needed to fill a civilian defense job is no excuse There are now thousands of classes being conducted daily and nightly by competent instructors in every phase of this vast program of help. Westchester county, for example, just north of New York City, has trained 30,000 of its residents as defense workers. Business men who commute to the city by day stand guard over aqueducts, pumping stations, and the like by night, while their wives graduate from Red Cross First Aid courses or maintain constant watch of the sky at aircraft warning posts.

It's the same all over the country. The Office of Civilian Defense has established nine regional offices —coinciding as to area and jurisdiction with the nine Army Corps Areas—and 48 state organizations, each of the latter being headed up by the governor and members of his state defense council. From there on down to the smallest community or rural area, a civilian defense council has been or soon will be established, and in each case it will be led by the head of the civil governing unit—the mayor of a city or village, the selectmen, the township or county supervisors. All existing services, such as firemen, police, and public utility repair crews will be used as nuclei for the organization of larger groups The American Red Cross is the only organization accepted as an entity, all other enlistments must be voluntary and must be individual in nature for reasons that are obvious. A men's civic club, for example, may enroll each individual member—presumably in the service for which he is best fitted—rather than joining en masse as an ambulance corps, or a decontamination squad, and so on.

One authority has stated that in the last war Germany devoted approximately 50 percent of her civil resources and energy toward winning the conflict. Today, it is estimated that better than 80 percent of all German civil existence is unalterably linked with active furtherance of Mr Schicklegruber's ambitions. On the other hand, England is said to have attained to about 40 percent of potential civilian effort toward wrecking those ambitions, yet the United States today can claim but 15 percent active civilian participation It has also been said that German leaders, advocating a truly all-out civilian participation in war effort, estimated that such additional impetus would this time tip the scales in favor of victory.

There can be no doubt but that the people of the United States can organize, build, and maintain the greatest civilian war effort the world has ever seen—if they have a mind to do so The Pearl Harbor catastrophe placed the stamp of action in millions of minds hitherto inactive on this subject, but we are still a long haul from 100 percent civilian co-operation. There's a branch of the United States Office of Civilian Defense in your neighborhood.—*A D R., IV.*

WAR-TIME GARDENS

THE United States Department of Agriculture is to be commended for calling a nation-wide conference to discuss and formulate a broad, co-ordinated program for enlistment in and guidance of a national campaign to encourage farm, home, and community gardens as a defense measure. If the goal for 5,760,000 farm gardens under controlled planting is even partially achieved in 1942, we shall all be healthier through better food habits, our home food supplies will be improved, and we'll try not to be hysterical this time and dig up golf courses and flower gardens in favor of potatoes!—*A. P. P.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of February, 1892)

OIL—"To-day the petroleum industry represents one of the greatest industries of the world. With gas and the electric light to compete against as illuminants, it is every year acquiring more importance, and holds a position as one of the three great sources of artificial light. . . In 1862 and 1864 the first suggestions toward transporting oil by lines of pipe were made, and in 1865 a pipe, 3,200 ft. long, was laid from Pithole toward Oil Creek, at Miller Farm. It could pass 81 barrels a day. . . At the present day the entire oil region is covered by pipe lines. . . Transportation trunk lines have been laid to New York, Philadelphia, Baltimore, Cleveland, and other points These lines are for the most part owned by the National Transit Co., which is, really, a branch of the Standard Oil Company, which controls practically all of the refineries, as well as the oil business of the United States"

Central oil refinery at Cleveland

CABLE—"The preliminary survey of the Hawaiian cable has been nearly completed. The *Albatross* has laid out a line from Salmas Bay across the Pacific . . The line laid down by the *Albatross* on its outward trip is slightly north of that laid down by the *Tuscarora* fifteen years ago. Several submarine peaks were encountered, but the bottom is for the most part regular and suitable for the bed of a cable."

ELECTRICITY—"High authorities cannot even yet agree whether we have one electricity or two opposite electricities. The only way to tackle the difficulty is to persevere in experiment and observation. If we never learn what electricity is, if, like life or like matter, it should remain an unknown quantity, we shall assuredly discover more about its attributes and its functions."

AIRPLANES—" 'So far as the mere power to sustain heavy bodies in the air by mechanical flight goes, such mechanical flight is possible with engines we now possess.' These words, coming as they do from Prof. S. P. Langley, carry with them the weight of authority. Nearly five years ago, Prof. Langley, then the director of the Observatory at Allegheny, Pa., commenced there a series of experiments in aerodynamics . . 'I am not prepared to say that the relations of power, area, weight, and speed, experimentally established for planes of small area, will hold for indefinitely large ones; but from all the circumstances of experiment, I can entertain no doubt that they do so hold far enough to afford assurance that we can transport (with fuel for a considerable journey and at speeds high enough to make us independent of ordinary winds) weights many times greater than that of a man.' "

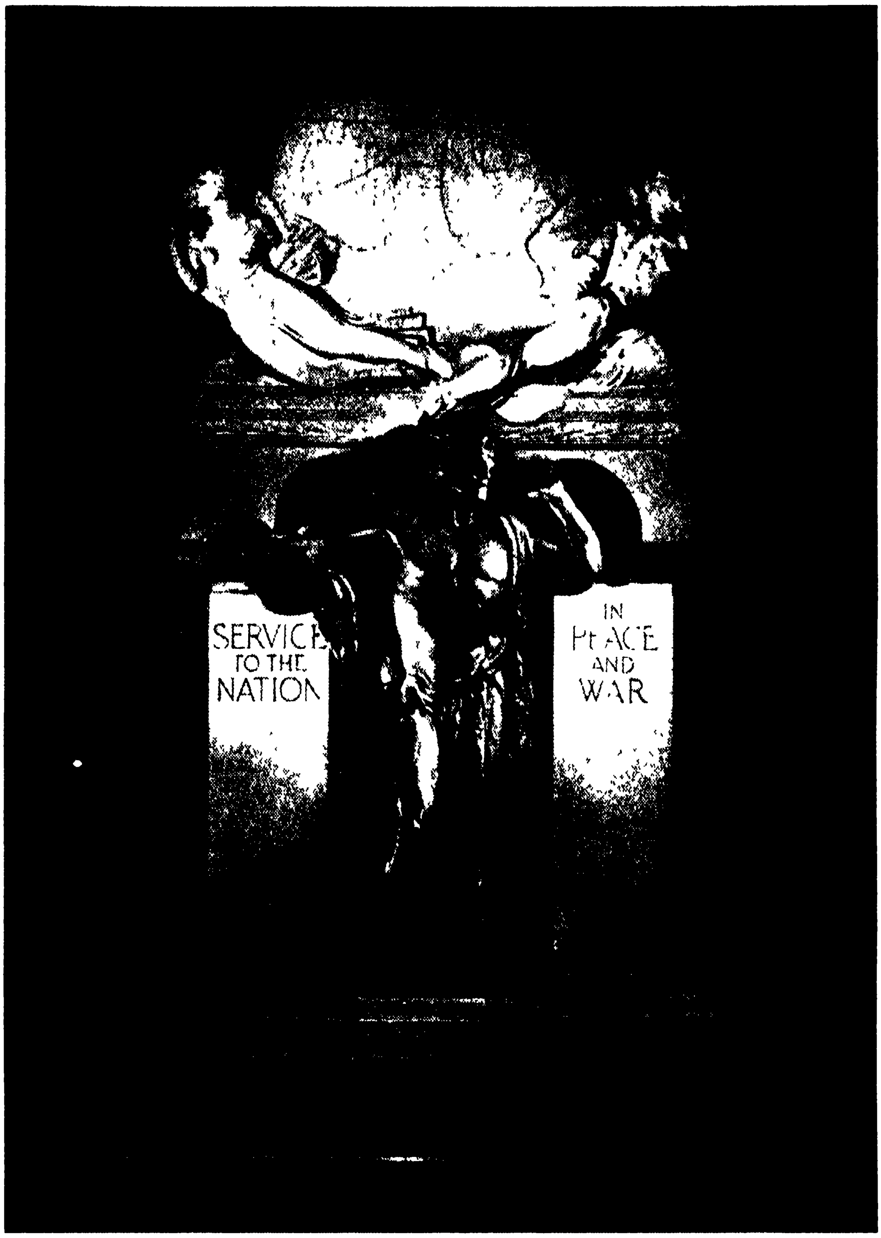
CAMELS—"Neither the most broiling heat nor the most intense cold nor extreme daily or yearly variations hinder the distribution of the camel. It seems, indeed, that the dromedary of the Sahara has better health there than in more equably warm regions; though, after a day of tropical heat, the thermometer sometimes goes down several degrees below the freezing point, and daily variations of 90 degrees occur"

ALUMINUM—"Taking into account the development made by the factories of aluminum in recent years, it may well be believed that the production almost equals the demand, although new uses for this light but ductile metal are being daily discovered. . . Toward the middle of last year American aluminum was quoted at a rate of $2 per lb.; some few months later the price was reduced to $1 per lb. The present prices are: For No. 1 quality, 90 cents per lb. in small quantities and 75 cents per lb. for orders of at least one ton, for No 2 quality, of a purity of from 94 to 97 percent, 65 cents per lb. for quantities of not less than a ton. These prices are quoted by the Pittsburgh Reduction Company"

TIME SIGNALS—"Some interesting experiments have been made by Mr. W. P. Gerrish on distributing time accurately by flashes of magnesium powder. Signals were thus sent from a station on Blue Hill, Mass., twelve miles distant. They were readily visible, and the exact time to within a fraction of a second could be taken from them. These flashes were also seen from Princeton and Mount Wachusett, forty-four miles distant, and from numerous nearer points."

INSANITY—"In the brain of a woman who had a visceral delusion, that was almost her sole idea, to the effect that a tape worm found a lodgment within the internal organs and came and went at pleasure, there was unilateral hypertrophy of the paracentral lobules, those in one hemisphere remaining perfectly normal. The patient was perfectly lucid and rational on all subjects except this one delusion, though it was difficult to induce her to speak of any other."

PEACE-WAR SHIP—"A new gunboat, the *Svensksund*, has been added to the Swedish navy. . . The vessel will, however, be more useful in time of peace than in war, as, first, she is a powerful ice breaker, fitted with water tanks for sinking to the desired depth; secondly, she is furnished with heavy gear for towing or hauling off stranded vessels; thirdly, she is equipped as a fire steamer, having ten large suction hoses and a centrifugal pump capable of delivering 22,000 cubic feet of water per hour; fourthly, she is fitted with condensers furnishing 800 gallons of water per hour; and fifthly, she is equipped as a torpedo repairing vessel."



"*Service to the nation in peace and war*"

Following the last World War a bronze and marble group was placed in the lobby of the American Telephone and Telegraph Company building in New York. On it are inscribed these words, "Service to the nation in peace and war."

They are more than words. They are the very spirit of the entire Bell System organization. In these stirring days, we pledge ourselves again to the service of the nation . . . so that "Government of the people, by the people, for the people, shall not perish from the earth."

BELL TELEPHONE SYSTEM

A LABORATORY "THUNDERCLOUD" TO AID AVIATORS

Laboratory study of atmospheric electricity is yielding facts that are being translated into practical instruments for use by aircraft pilots. The experimental set-up of a "cloud charge indicator for airplanes," shown above and described in detail on page 78, has resulted in the design of an instrument weighing only two pounds that will furnish a pilot with an indication of the electrical intensity in the air ahead, thus enabling him to decide whether or not he should change his course

98TH YEAR SCIENTIFIC AMERICAN FEBRUARY 1942

'MAID-OF-ALL-WORK'

Place of the Versatile Destroyer in Modern Navies

WALTON L. ROBINSON

With the possible exception of the stealthy submarine and the tiny, ultra-swift motor torpedo boat, there is no class of warship whose past and present exploits have been more daring than that "Maid-of-all-work"—the torpedo-boat destroyer Originally conceived to combat torpedo boats (hence its name, now shortened to simply "destroyer"), it soon took over their duties and later assumed several additional ones, with the result that today no other fighting ship can carry out so many varied tasks With its armament of torpedoes, depth bombs, and guns, the destroyer must now be reckoned with by the enemy's forces on, under, and above the sea

In a general fleet engagement destroyers are indispensable for attacking and screening duties, while on detached or independent service they are extensively used for such important work as laying and sweeping minefields, raiding enemy commerce, escorting convoys of merchant vessels, and waging a ceaseless campaign against the marauding submarine. It is to fulfill these last two missions that the United States and Great Britain so urgently need every destroyer that can possibly be built

Modern destroyers vary greatly in size and strength of armament, but all of them are swift, handy craft, able to face seas which quickly would have forced the boats of a few decades ago to seek shelter in port. Those displacing less than 1000 tons are now generally classed as torpedo boats, while the relatively few of more than 2000 tons are, in reality, small, very fast light cruisers. France, Italy, and Russia are the only powers which possess these "super-destroyers." What may be considered the destroyer proper is a boat displacing between 1000 and 2000 tons, able to attain a speed of 33 knots or more, and armed with four to eight guns of 4.7-, 5-, or 5.1-inch caliber (diameter of bore) and four to sixteen torpedo tubes All of Britain's modern destroyers mount 4 7-inch guns (four, five, six, or eight in number) and most of them have eight or ten torpedo tubes. Germany's *Grosse Torpedoboote* ("large torpedo boats") have a uniform armament of five 5-inch guns and eight tubes. Italian *cacciatorpediniere* ("torpedo boat chasers") are noted for their very high speeds (39 knots in the newest units), but have only four or six 4.7-inch guns and a correspondingly weak torpedo armament. Japanese *kuchikukan* are rather slow (34 knots), but are reasonably well armed, they carry four to six guns and from six to nine torpedo tubes.

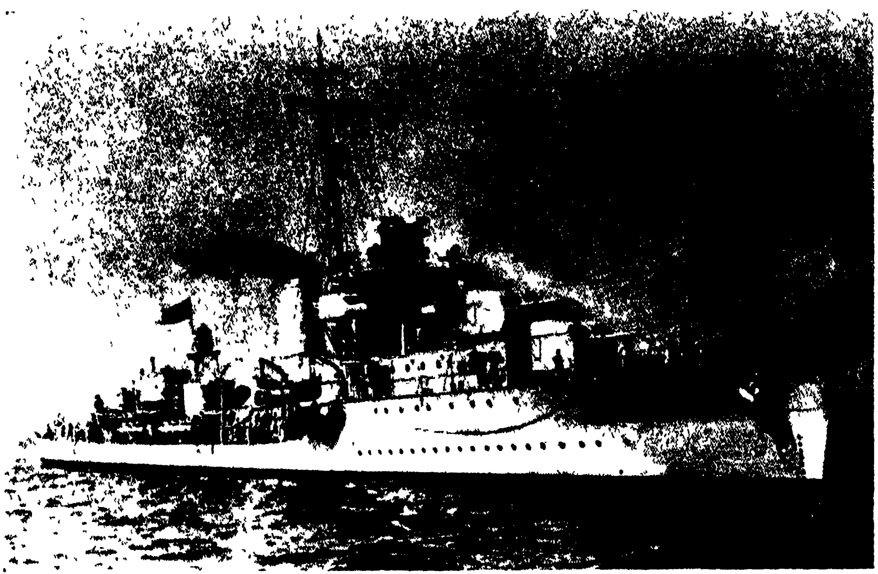
NATIONAL DEFENSE

● **INTEREST in destroyers was enhanced when, last year, the United States sent 50 of these singular warships to Britain. Attacks on the *Kearny* and the *Reuben James* focused the spotlight more clearly. As this is written, Pacific naval warfare has thrust this branch of our Navy into a leading role. Just what are destroyers? How large are they? What are their duties? Why do we and Britain need them so desperately? In these days of history-on-the-blitz, one hardly knows what turn may be taken by the time an article appears in print. Nevertheless, this story essays a reply to the above questions. —*The Editor.* ●**

American destroyers have always been remarkable for their very powerful torpedo armaments. Some of our most recent units are provided with as many as sixteen tubes, while even the "flush deckers" of 1916-19 vintage boast twelve. All of our under-age boats, the oldest of which were begun in 1932, mount eight, ten, twelve, or sixteen tubes and from four to eight 5-inch "double purpose" guns, so called because they can be employed against aircraft as well as warships Our largest destroyers, the five of the *Somers* class, displace 1850 tons and carry eight guns and twelve torpedo tubes. Designed to operate as squadron leaders, they are among the most powerful vessels of their type afloat

Thus, we have an outline of the destroyer's principal characteristics and can now examine its tactical possibilities in modern warfare. First come its various duties in a fleet engagement, then its several forms of employment on detached service. In either case the destroyer's work may be of an offensive or defensive character, though in the performance of the latter, action of an aggressive nature is often required

In a major fleet battle the destroyer has two offensive missions to fulfill The principal of these is to carry out torpedo attacks on the hostile battleship column. To be most efficacious, such attacks must be delivered by one or more squadrons (flotillas), supported by cruisers to assist in piercing the protective screen of enemy light craft. On arrival within effective range, say 6000 yards, each destroyer will carefully calculate the



All photos courtesy U S Navy Recruiting Bureau

A typical American destroyer: 1500 tons, speed 36.5 knots

enemy's course and speed, will discharge all or most of its torpedoes, and then retire at full speed under cover of dense clouds of smoke. Such attacks *en masse* are far more likely to achieve success than isolated ones made haphazardly by only a few boats, for the more numerous the torpedoes approaching an opponent's battle line, the more difficult will it be for his ships to avoid them Two squadrons of our modern destroyers—a total of 18 boats—could launch at a given signal over 100 torpedoes, and this number of "tin fish" rushing simultaneously toward an adversary's column of dreadnoughts should score a high percentage of hits. One or two hits on a ship would cause it to lose speed and probably to leave the battle line, while several more would most certainly send it to the bottom. The value of the torpedoes discharged in such an attack would amount to considerably more than a million dollars, while a number of the participating destroyers would likely be sunk or badly damaged. Should the present war produce a large-scale naval action, say between the British and Italian fleets in the Mediterranean or between the United States and Japanese fleets in the Pacific, such massed attacks by surface torpedo craft would undoubtedly play a prominent part and might well decide the issue

The destroyer's other offensive function in a fleet battle is the laying of what are termed tactical minefields. An operation of this nature was carried out at Jutland by H.M.S. *Abdiel*—a destroyer with its torpedo tubes replaced by mine racks. During the night this boat laid mines in advance of the retreating enemy fleet, but the Germans altered course and avoided the newly sown minefield, of whose existence, however, they were completely unaware. Despite the failure of the tactical minefield on this occasion, the idea was an excellent one deserving of success. That this form of warfare is considered to hold much promise is indicated by the fact that practically all navies possess a number of destroyers fitted for minelaying. The Italian and Soviet navies are especially enthusiastic about its possibilities and the vast majority of their destroyers are equipped to lay mines.

THREE vitally important defensive tasks fall to the lot of destroyers assigned to the battle fleet. During a major operation, and while the fleet is still in cruising formation, destroyers must screen the great dreadnoughts from possible submarine attack In the performance of this mission they rely chiefly on the depth bomb. In the present conflict Italian submarines in particular have attempted frequently to interfere with the British Fleet's movements in the Mediterranean, but their successes thus far have been out of all proportion to their heavy losses Not a single British battleship has been sunk by Italian submarine action, and only one is believed to have suffered damage.

Soon after contact with the enemy's fleet has been established, destroyers will be called upon to repel hostile torpedo attacks and to lay protective smoke screens. They can best accomplish the former task by dashing out and engaging the attacking flotillas before they arrive within effective torpedo range. Both sides will dispatch cruisers to support their destroyers and much hard fighting will ensue. The result of this secondary action will exercise a profound influence on the course and outcome of the battle raging between the big ships.

SMOKE screens are employed to conceal from the enemy some intricate maneuver or to protect a badly damaged ship. They are invariably resorted to by a fleet wishing to withdraw from the action. In the engagement off Punto Stilo on July 9, 1940, between the Italian and British fleets, the former and inferior force succeeded in escaping almost certain disaster by retiring at full speed behind dense curtains of smoke emitted by a destroyer flotilla.

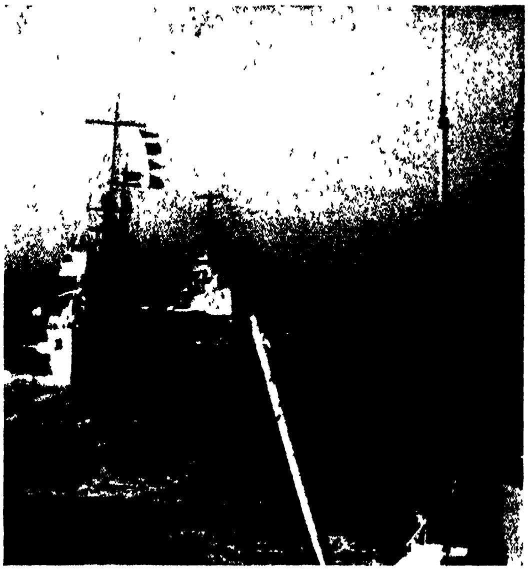
Tactical scouting with other advance units of the fleet is yet another duty which falls to the destroyer, for there will never be sufficient cruisers to do this work, while bad weather or lack of carriers or nearby shore bases may preclude the effective use of aircraft. During the past two years there have been several naval actions in which planes were unable to participate due to one or more of these reasons.

Of the destroyer's several duties on detached service, anti-submarine operations are by far the most important. These may take the form of escorting large convoys of merchant vessels, patrolling defined danger zones, or laying mines at the exits of the submarine bases. In the first two cases the destroyer's most effective weapon is the depth bomb, although occasions may arise in which gunfire, torpedoes, or ramming tactics can be employed. Depth bombs were invented during the last war and proved so successful that they now form part of every destroyer's armament. They are either rolled overboard from racks at the stern or are discharged from a projector known as a "Y-gun" Detonation at practically any desired depth is effected by hydrostatic pressure. The explosive force of the 300-pound charge of trinitrotoluol—TNT—will destroy or seriously damage an undersea boat within a radius of seventy to one hundred feet. Even if the submarine is not sunk or badly damaged, it is probable that the morale of its crew will be so shaken as to necessitate an early return to port. Many submarine crews have testified to the demoralizing effect of a barrage of depth bombs exploding near their craft.

Depth bombings are today far more likely to achieve success than was the case 25 years ago. Their increased effectiveness is due in large part to improved methods of detecting a submarine's presence and exact whereabouts beneath the surface. In the last war the only device for such work was the hydrophone, which located the undersea craft by picking up the sound of its motors. In those days, consequently, all that a U-boat had to do after attacking an escorted convoy was to rest on the bottom with motors quiet. Nowadays, however, the problem confronting an Axis submarine commander is much more difficult, for in the years between the last war and the present one the British invented a truly marvelous submarine detector. Popularly known as the "Asdic" (after the Anti-Submarine Detection Investigation Committee), it can locate a submarine lying on the bottom almost as readily as it can one which is under way. The "Asdic's" very existence was among the Royal Navy's most closely guarded secrets prior to the outbreak of war, and the Germans did not discover how it functioned until after the fall of France, when they examined a number of French destroyers.

In the present conflict the Axis navies have lost a very considerable number of submarines. It is impossible to state the precise extent of their losses, but about one hundred German *Unterseeboote* and nearly half that number of Italian *sommergibili* are believed to have been destroyed. The majority of these boats were sunk by depth charge attack, while mines and aerial bombing accounted for most of the others. Axis destroyers, mines, and planes have taken, of course, their own toll of British and allied undersea boats. During the first two years of war the Royal Navy alone lost 29 submarines by enemy action. While the exact fate of most of them remains unknown, it is safe to assume that fully half were sent to the bottom by depth charges. Several, however, were sunk by ramming. Such tactics, incidentally, often result in considerable damage to the destroyer's bow—sufficient in most cases to put her out of service for several weeks.

Minesweeping is a very important and extremely dangerous task which destroyers are sometimes called upon to perform. They should not be employed in this work, however, except in emergency for they are too valuable and needlessly large and fast. Smaller, less costly craft, either specially built or converted, can discharge this duty in an equally efficient manner.

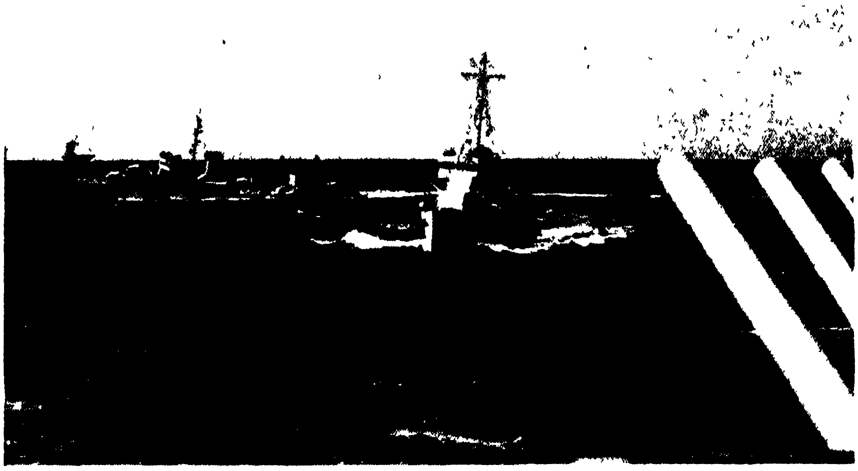


Destroyers maneuvering

Commerce raiding is yet another mission which destroyers can carry out. Prior to the outbreak of the current war, this work had been entrusted almost exclusively to cruisers. Britain's perennial shortage of cruisers has obliged her, however, to dispatch destroyers to assist in the capture or destruction of those enemy merchant vessels which from time to time slip out of neutral ports in an effort either to supply some raiding warship on the high seas or to run the blockade and return home. This task the fragile destroyers of 1914 were incapable of performing, but the modern ones, with their wide radii of action and splendid seakeeping qualities, have had little or no difficulty in carrying out such assignments.

That destroyers are constantly being employed on service of the most hazardous nature is evidenced by the great number which have been sunk during the past two years. Excluding small units of less than 1000 tons displacement, over 100 destroyers have fought their last action. Numerically, Britain heads the list with some 50 lost, while Germany and Italy have suffered even more heavily in proportion to the size of their navies. (At the time of writing it is still too early to give accurate and official data on losses in the "Battle of the Pacific.")

Britain's losses represent about



Destroyers at sea. Note airplane carrier in distance

A division of destroyers in tactical exercises

30 percent of her destroyer forces available in September, 1939. Since then she has strengthened her navy by at least 80 destroyers, including the 50 acquired from us. Thus Britain's present-day strength comprises over 200 destroyers. This number is far from adequate, however, for Germany now has in service many more U-boats than was the case two years ago. At that time some 70 Nazi submarines were ready for sea, while today probably twice that number are operating against Britain's vital sea communications Moreover, Germany is building U-boats at a furious pace: our Navy Department estimates that she is rushing work on nearly 200. The collapse of France and Italy's entry into the war have also done much to increase the Royal Navy's difficulties, for the French possessed about 70 destroyers and torpedo boats, while the Italians added more than 100 submarines to the enemy's strength

The coming months will doubtless witness much bitter naval fighting as the "Battles of the Atlantic and Pacific" rage between German, Italian, and Japanese undersea craft on the one hand and the anti-submarine forces of the United States and her allies on the other. In this life and death struggle the destroyer will assuredly share many of the honors. Perhaps some new missions will be discovered for it, though what they might be defy the imagination, as already it is capable of such varied service Well, indeed, has the destroyer earned the sobriquet: "Maid-of-all-work."

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Inch by Inch, Tooth by Gear

Army Officers Receive Technical Training in Motor Vehicle Operation and Up-Keep

FROM Second Lieutenant to Lieutenant Colonel, officers of the streamlined, motorized divisions of our fast growing Army are attending each week in Detroit a school conducted by Chrysler Corporation in advanced technical training in the operation and maintenance of the thousands of speedy, sturdy motor vehicles in which our present-day fighting forces ride instead of march in maneuvers and in cantonment routine at speeds up to 50 miles an hour.

Each Monday morning at 8 o'clock sharp, officers from the Army posts scattered across the country assemble in the Army School class room. During the first half-hour they are registered and given their schedule of intensive training for the week.

Actual school work starts promptly at 8:30. The men are divided into four groups, each under the supervision of a trained instructor, an experienced, qualified, automotive service specialist. Two full hours are devoted to the subject of wheel alignment. Each officer is instructed and given actual practice in the mechanics of caster and camber of front wheels. They learn the meaning and importance of proper wheel alignment—the effects of misalignment. Each man is given an opportunity to check the wheels with special gages. They discuss causes and effects informally but thoroughly

From 10:30 to 12:00 o'clock each group probes the intricacies of an Army truck's electrical system—its nerve structure. They "dissect" the generator, examine its insides, check the wiring, the condenser, distributor, and all the elements that are a part of or affect the electrical apparatus

Lunch period is from 12:00 to 1.15 P.M. Shop work continues from 1:15 to 4:00 o'clock. The men disassemble and reassemble brake mechanisms, make brake adjustments, bleed the lines of the hydraulic brake system. They discuss the common and uncommon causes of brake trouble, excessive wear and other complaints.

From 4:00 to 4:30 P M. they return to the class room for a question-and-answer period to clear up any misunderstanding or details that might not be clear in the mind of any man regarding the subjects covered during the first day of the school.

On each succeeding day the hours for discussion in the class room and shop work at the benches are about the same, but during each period a different subject is taken up. At the end of the week, when the officers depart for the return

Army trucks go through their paces

trip to their respective Army posts, they have gone over, inch by inch and tooth by gear, the vital mechanical parts of the Dodge Army trucks that are being turned out by the thousands in various types for Army use.

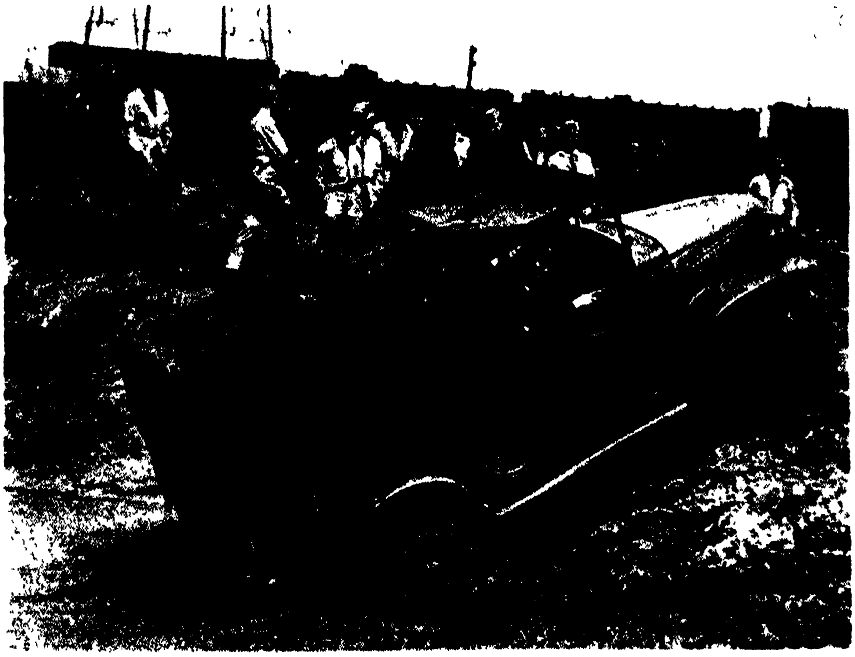
From beginning to end in all instructions, in all theory, in shop work, and in discussions, preventive rather than corrective maintenance is stressed with all possible emphasis. "A stitch in time" is what keeps the Army rolling. The men and the weapons and the supplies of a modern, fast-moving Army can't stop and wait for a truck to be repaired When a vehicle fails and can't keep going, it is simply left by the wayside and the Army rolls on.

THE officers are taught to become familiar with the sound of engines, transmissions, differentials, generators, and various other moving parts so they can detect the noises that are apt to mean trouble Impending trouble detected by the sound of a vital unit usually can be corrected before serious damage results, thus preventing failure or delay.

A highlight of the training course is the "scrambling" of an engine. The timing gears, carburetor, electrical apparatus, and all possible units and attachments are purposely thrown completely "out of kilter." Each man takes his turn "unscrambling" the mess, putting each part back in proper adjustment and working condition

Army officers learn truck motor maintenance

Practical training in driving Army trucks in rough going on a specially constructed testing ground adjoining the Dodge truck plant near Detroit forms the spectacular and exciting part of the training course Each Wednesday afternoon is devoted to a driving field day for the Army men. The officers take turns driving the reconnaissance cars, command cars, weapon carriers, troop transports, cargo transports, and ambulances over precipitous grades of 60 percent and more, through a veritable mud-wallow in which the wheels of the trucks drop practically out of sight, over rutted fields and bogs, and through second-growth brush.



Officers at school drive a truck through a mud wallow

Each Friday afternoon the officers are taken on a tour of the corporation's engineering laboratories, where they see how the important parts of the motor vehicles are tested in a thousand ways to duplicate days, weeks, months, and years of stress and strain.

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SMOKELESS POWDER

Chopped-Up Cotton Speeds Production

COTTON linters, the fuzzy threads left clinging to cottonseed hulls after ginning, has always been the best material for use in the preparation of smokeless powder. Present-day demands for powder production, however, have long since consumed the available supply of linters. Other cotton fibers are too long to use in powder production since they tend to "spin" or "rope" in the nitrating machinery and clog the works

Now, however, long cotton fibers can be reduced to an approximation of the length of linters by new machines invented by United States Department of Agriculture engineers. The long cotton fibers are first reduced to medium lengths which in turn are sent through a second machine where the fibers are chopped into the equivalent of linters.

Shutters and Cutters

High-Speed Motion-Picture Photography Used in Study of Machine-Tool Cutting Edges

B. L. McKENZIE

High-speed photography, famous for its trick shots of golf strokes, tennis strokes, and the like, may soon become equally famous for its value to industry as an aid in determining how to bring closer to perfection the design and the performance of milling cutters, lathes, planers, and many other similar machine tools. Such is the conclusion to be drawn from an experimental series of photographs made by this method in the course of the past year.

Set-up for taking high-speed photographs of machine tools, to study action at the cutting edges

Until a short time ago, very little was definitely known about the action that takes place at the cutting edges of machine tools It was known, for example, that chips cut from certain materials break off and are thrown clear of the cut, whereas in other cases the chip is removed in a continuous curled strip; that a certain amount of distortion takes place in the material cut away; that abrasive action on the tool occurs during cutting; that in dry cutting there is a tendency toward a welding action between the chip and the tool face; and that a certain amount of chatter in the machine is present at times

But because the action of machine tools is far too fast to be seen and studied by the naked eye, it was formerly impossible to determine exactly what does take place at the cutting edge. In an effort to gain knowledge on this subject, the General Electric Company developed the necessary lighting equipment to make—and then made—the series of high-speed machine tool photographs.

In the high-speed camera adapted to the purpose, an Eastman Kodak type II, exposures are controlled by a shutter, and images are moved with the continuously moving film by means of a revolving prism, which is used in addition to the objective lens.

Using 16mm film, and operating at a speed of 1000 frames per second, 100-foot spools were exposed in four seconds, the footage exposed in one second requiring one minute to view when projected at normal speed. Built into the camera was a delicate pair of timing dials which, controlled by a 200-cycle tuning fork, indicated respectively seconds and thousandths of a second, and were photographed on the right-hand edge of each frame, rendering an accurate account of the amount of movement taking place in a given amount of time.

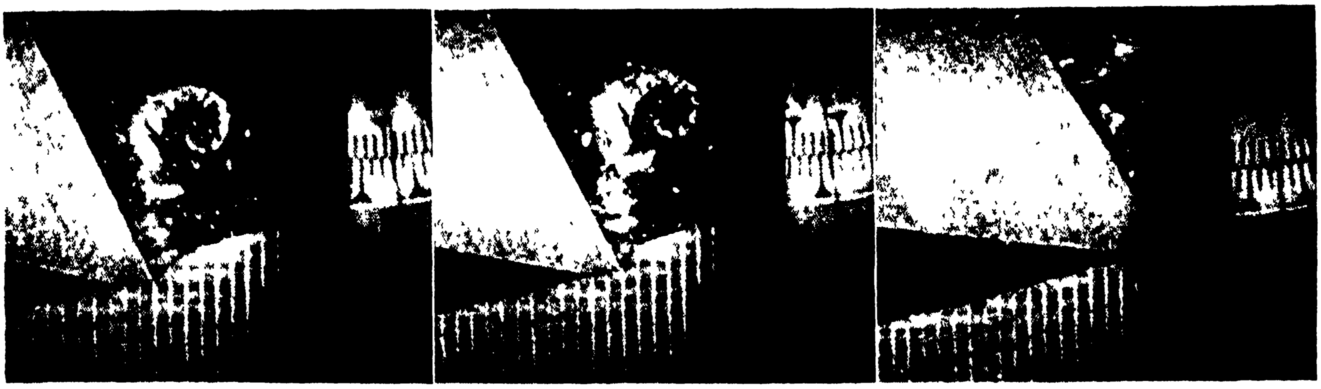
Principal problem in making the high-speed pictures was that of sufficient light. Since the largest practical lens aperture that could be used was about $f/2$ and the exposure time approximately 1/4000th of a second, a light approximately five times the strength of sunlight was required to produce a clear image on the negative.

Work on the series of pictures was done at night and during weekends to avoid vibration from neighboring machines. Two high-power lamps were trained directly on the area being photographed, one lamp being placed at each side of the camera to eliminate confusing shadows. Since action in these cases was localized in a very small area, it was possible to place the camera close enough to the work to make pictures of areas one-inch square and ¼-inch square, thereby permitting movement measurements to within a few thousandths of an inch to be made, on examination of the finished pictures, with a fair degree of accuracy.

The workpieces from which chips were cut were marked in squares 1/32 of an inch on a side, to facilitate study of the material both during the cutting process and afterwards, and to permit identification of the metal in chips with regard to previous location in the block of material.

Tools studied in the photographic series were milling cutters and planers, used without coolant, an effort being made at all times to simulate normal operating conditions — normal operating speeds and feeds. A narrow workpiece was selected for cutting, in order that all of the separation of the chip from the block would take place at one cutting surface. Thus the action observed at the side of the workpiece was the same as that taking place throughout the width of the cut, and in addition — since chip action was in a vertical plane — an unobstructed view of the work by the camera lens was possible.

In photographing conventional milling, materials cut were SAE 1020 steel, of Brinell hardness 160; yellow brass, Brinell hardness 130; and cast iron, Brinell hardness 170. Standard milling cutters were used, at a speed of 37 surface feet per minute, taking a 3/16-inch cut, with a table feed of 30 inches per minute. In photographing climb milling, materials cut were SAE 1020 steel and ascoloy. Cutting speed for the climb milling process was 42 surface feet per minute, with a seven-inch per



The three high-speed photographs above show a milling cutter cutting cast iron. The characteristic segmental chip of cast iron is evident. In picture at right, chip has been detached from work. Note 1/32-inch cross markings on workpiece. Photograph below shows planer cutting brass. Distortion of work is shown by the cross markings, which serve as indices for study

minute table feed, the cut taken being the same as in the conventional milling photographs — 3/16 of an inch. Various types of standard cutters were used for these operations

For the purpose of further study, special cutters were then ground, and photographed at work. The first of these, designed to show the difference in cutting action between sharp and dull teeth, was ground with 10 teeth sharp and 10 teeth dull. The second was ground with two teeth of zero rake angle, followed by two of 5-degree negative rake, two of 10-degree negative, and two of 15 degrees, the remaining teeth being ground with 5, 10, and 15-degree positive rake angles.

In the planing operations photographed, several different materials were cut, with forged high-speed steel tools, one inch by 1½ inch by eight inches long. 18-4-1 high-speed steel tools were used to cut steel, yellow brass, and cast iron, operating at 37 surface feet per minute, the depth of cut being .040 inches; these tools were further photographed cutting, at 60 surface feet per minute, two pieces of steel of different hardnesses, which were clamped end to end on the planer so that one cut followed the other. Carboloy tools were then photographed in use on the planer, cutting these same two materials at 160 surface feet per minute.

With the aid of the 1/32-inch horizontal and vertical lines marked on the workpieces photographed, plus the camera's built-in timing dials, it was possible to plot true time-distance graphs for the alternate forward motion and retarding of the teeth of a cutting tool in action. This was done by projecting the developed pictures, one at a time, on paper marked off in large squares, moving the projection machine until the small squares in the pictures were superimposed on the large squares on the paper. Thus graphs could be drawn to scale, the sides of the large squares corresponding to the 1/32-inch sides of the squares marked on the workpieces.

From these time-distance graphs — together with viewing of the film projected as a motion picture, and study by photomicrography of the structure of the chips and the completed machined pieces — have been learned facts that may be of inestimable value in the constructing of future machine tools; in the designing of the "machine" and the grinding of the "tool."

Through the use of high-speed photography, for example, can be determined the maximum speed at which a given machine tool can be operated without danger of erratic operation, caused by inertia of material being cut or too great deflection of cutting teeth — without danger of distorting the material being cut to such an extent as to render the material unsuited for the application in which it will be used.

Photographs have shown, among other things, that material ahead of the tool is distorted in the direction of the tool's movement, causing distortion not only of the chips cut away, but of material below the line of the cut. They have shown that compression on and consequent deflection of a tooth, as it builds up power to begin the cut, is much greater at the beginning of the cut taken than when the end of the cut is neared, due to the larger amount of material ahead of the tool in the beginning. They have shown that the speed of the tool is directly related to such compression and deflection.

Maximum speed without danger of deterioration, due to heating, of the tool's cutting edge can also be determined. Perhaps most important of all, where speed is concerned, is the fact that the maximum speed possible with minimum regrinding of tools can be accurately fixed, resulting in the highest possible efficiency of a given tool; that is, the highest possible number of cubic inches of material removed, the greatest number of finished pieces turned out, in the least possible time, with the minimum number of tools.

Causes of chatter — that is, the wind-up in the arbor when heavy deflection occurs, and the irregular feeding of tables — can be studied, and in many cases might be remedied by improving smoothness of feed and by operating at slightly lower speeds, thus reducing vibration and lengthening the life of the machine as a whole.

The most efficient rake and clearance angles to provide the largest amount of material cut away at the greatest speeds may be determined. By improving rake and clearance angles, not only might it be possible to produce a more accurate machined surface, with less slipping and greater smoothness of action; it might also be possible to control the action of the chip, with the purpose of lessening its abrasive or "cratering" action on the face of the tool, thus lengthening tool life.

It can be learned, through photographing teeth of different degrees of sharpness, the length of time the tool can be efficiently used before regrinding, as well as just which coolant is most effective, on a given type of cut in a given material, in reducing abrasive and welding action between chip and tool face and in reducing the built-up edge of material which accumulates on the cutting edges of the tool and appreciably slows up its action.

With the information gained through studies made by means of high-speed photography, when such studies have been made in sufficient number, it is believed that changes can be made in the designs of various types of machine tools which will make it possible to obtain from these tools maximum efficiency and the speed so vital, during these times, to American industry.

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Glass Blocks Bend Light

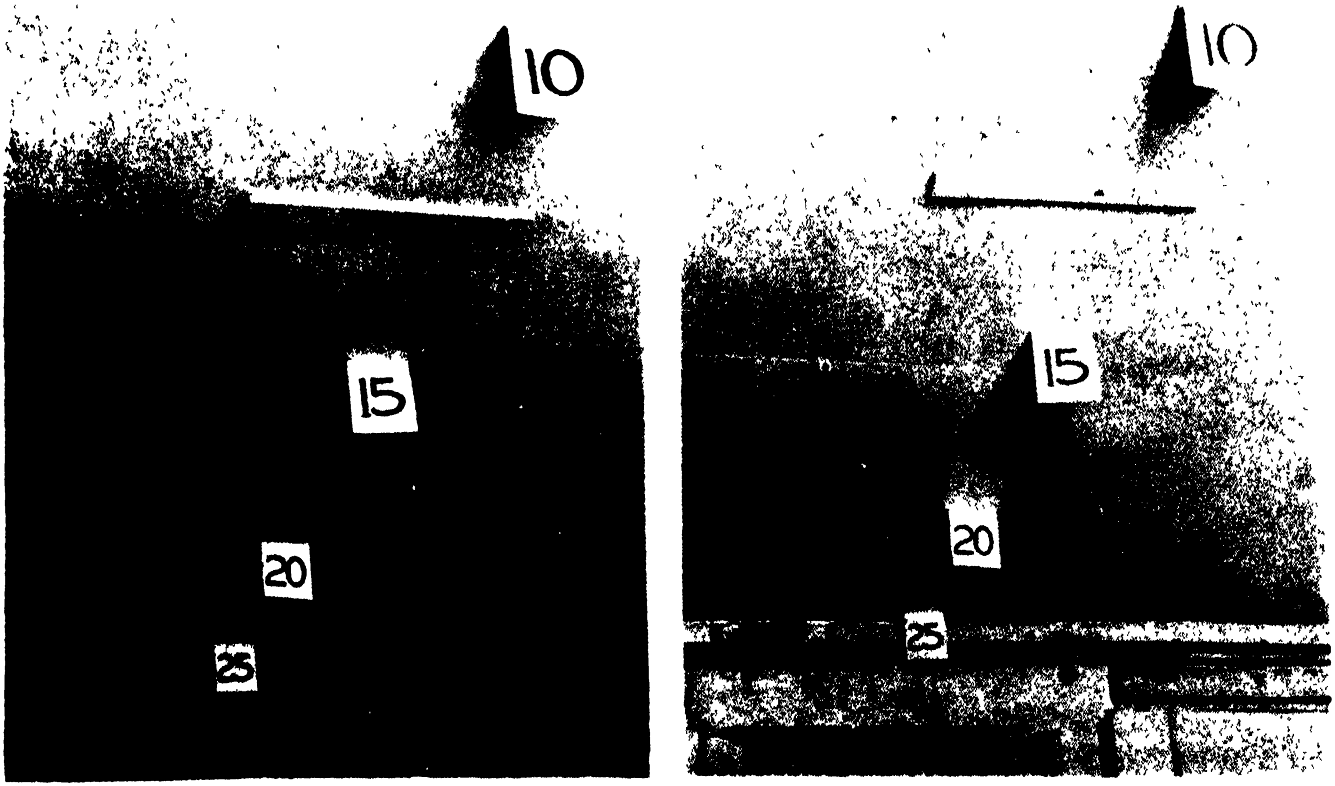
Daylight Conservation Achieved by Refraction of Incoming Light to Ceilings and Sidewalls

THE current national emergency and its speeding up of industry has caused a drain on the nation's power resources, especially in the east and southeast. Hence lighting engineers, in an effort to conserve as much *daylight* as possible, have been experimenting with different means of providing maximum useful daylight for interior illumination of office buildings and industrial plants. The most successful test reported to date involved panels of Insulux glass blocks, which, used in place of windows, provided more usable daylight, more evenly distributed.

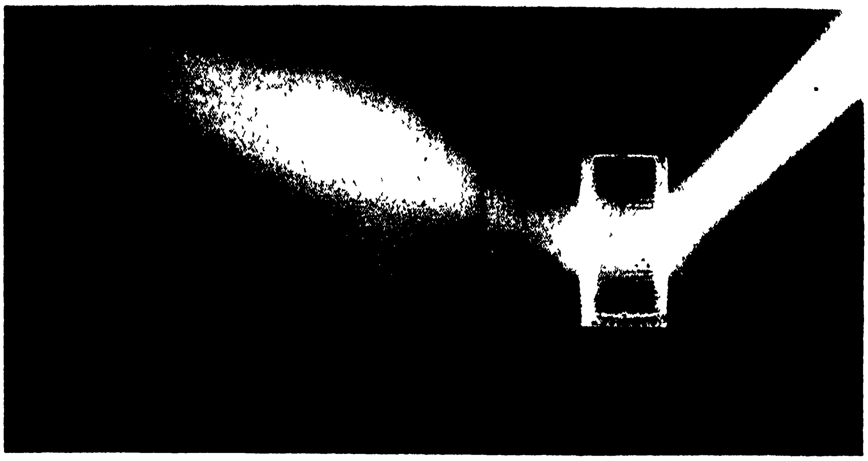
These blocks, which incorporate interior prismatic sections, serve to bend or redirect light rays, so that instead of falling in a direct line downward toward the ordinarily dark floor, the rays are turned upward toward the ceiling and upper walls These surfaces, in turn, reflect the light down and toward the interior. This system of daylighting was developed by the Insulux Division of the Owens-Illinois Glass Company. It is claimed that no system of louvers, reflectors, or baffles now in use equals it for all-around efficient use of daylight indoors.

THE engineers working on the lighting tests used an ordinary room with dimensions of 23 by 25 feet with a single unglazed opening in an exterior wall. Immediately after pictures were made of the room in that condition a panel of Insulux glass blocks was installed in the opening and other photos taken. All of the photos were made with the same camera on the same film, under brilliant sunlight conditions, with identical exposures. Prints were given the same exposure by the printer and were not retouched.

The results were striking. The pictures taken of the room with



Left: **Light from unglazed opening compared with** ***(right)*** **light through new glass block**



Section of glass block, showing how light rays are refracted

the unglazed opening show a poor and inadequate diffusion of light, the dark floor having absorbed much of the direct light which streamed in through the opening. When the glass-block panel was installed, the light striking the outside of the panel was redirected upward toward the ceiling and diffused deep into the interior due to the prismatic design of the blocks. Instead of falling, then, on the dark, highly light-absorptive floor, most of the light was directed at the upper half of the room. These surfaces reflected it downward to the working levels.

The fact that the prismatic blocks are translucent insures complete privacy at all times, an essential to many defense plants. Besides redirecting daylight efficiently, they serve as insulation against all types of weather; because of their insulating qualities they retain within the structure much of the cooling temperatures achieved with air-conditioning units.

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SAFE AT WORK

Better Lighting Reduces Industrial Hazards

AMERICA'S 6,000,000 men and women industrial workers handling complicated machinery and entrusted with the task of producing the nation's weapons for defense at an accelerated tempo, are safer from injury at work than at home or in automobiles.

This is true primarily because of the development by research of new light sources such as fluorescent and mercury vapor lamps now widely used in factories, according to Oscar P. Cleaver, well-known Westinghouse lighting engineer. United States defense industries, says Mr. Cleaver, now use two to five times more light than ever before over workbenches and production aisles to speed output and minimize possibilities of accidents involving workers.

"Industrial leaders realize," he declared, "that more light flooding work areas increases efficiency and cuts down injuries at a time when production must not be disturbed. We cannot afford to lose workers. While we can replace machines, we cannot easily replace highly skilled employees."

Latest available statistics compiled by the National Safety Council, Mr. Cleaver disclosed, report that more than twice as many fatal accidents occur in motor vehicles as in occupational pursuits, and approximately twice as many occur in homes as in industry.

"In recent years," he said, "surveys show that light in factories throughout the nation has been rated at an average of about 10 footcandles, as compared with ideal light in the shade of a tree of approximately 1000 footcandles.

"Under these conditions, statistics reveal that about 140,000 injuries could be expected among 6,000,000 workers in a year. Of this number, one out of four, or 35,000 of the anticipated injuries would result in permanent loss of vision."

This situation is changing for the better, the engineer said. In many defense plants, lighting intensities are now often maintained at averages varying from 30 to 50 footcandles. For close work as many as 100 footcandles are supplied the worker.

"Until research laboratories successfully developed fluorescent and mercury vapor lamps," Mr. Cleaver explained, "it had not been practical nor possible to raise lighting levels in industry. The fluorescent lamp, however, is cool, is approximately twice as efficient as an incandescent, supplies glareless light, and is economical to operate when burned long periods of time. Mercury vapor lamps have also become an important source for an abundance of light under certain conditions."

More than 10,000,000 fluorescent lamps were in use in this country early in 1941; during that year the lighting industry estimates that an additional 20,000,000 were put into service.

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LIGHT: Approximately 156,000 fluorescent lamps are being used in the world's largest installation of these tubular light sources. They are being placed in the $47,000,000 Ford bomber plant near Ypsilanti.

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TWO LAYERS

Of Plated Metals to Replace Galvanizing

DRASTIC curtailment in the metal-coating industry has stimulated interest in the new Corronizing process, which is claimed to reduce by 50 to over 90 percent the necessary tonnages of zinc and tin used for galvanizing and tinning ferrous and non-ferrous metals.

Corronized coatings, already in use by several licensed manufacturers for various sheet, strip, and wire products, consist of several exceptionally thin layers of metal and alloys, having unusual corrosion-resistant properties. The coatings are formed by electroplating a thin layer of nickel on the base metal, followed by a layer of either zinc or tin much thinner than ordinarily used for equivalent galvanized or tinned coatings. Conventional electroplating equipment and standard plating solutions can be utilized with only minor changes, the novel features of the process arising from the technique of application and subsequent treatment. After the two metallic layers have been plated on, the coating is baked at a fairly high temperature (500 to 750 degrees, Fahrenheit) for up to one hour, during which time the two metals mutually diffuse to form new layers of alloys of different composition. The resultant coating not only is highly resistant to corrosion in salt spray, humidity, and normal atmosphere tests, but it is reported that it can be twisted, bent, molded, soldered, and even welded satisfactorily.

Applications of Corronizing now in production by several manufacturers include insecticide spray tanks, wire screening, copper oven thermostats, and outboard motor parts, while tests have been made on other products such as welded wire fences, pump rods, oil cans, springs of surgical appliances, metal stampings, and formed parts.

A main present disadvantage of Corronizing is its use of nickel, even though only a small quantity of nickel is required to save much larger amounts of zinc or tin.

While atmospheric exposure tests are not yet completed, preliminary indications are that the superiority predicted by accelerated tests will be fulfilled in actual use It is further claimed that the coating has some tendency to self-heal when failure occurs, thus slowing up complete deterioration, while ordinary galvanized coatings fail after part of the coating has been corroded away.

Because of the reduced quantities of metals necessary for a given quality of protection, Corronized coatings are now said to compete in cost with hot-dipped and electroplated zinc coats in the lower-quality field, though its possibilities have not been definitely established for higher-quality applications of various kinds.—*The Industrial Bulletin* of Arthur D. Little, Inc.

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ERASERS—Plastic eraser holders on pencils, in which one pound of plastic replaces about two pounds of metal, released an estimated 150,000 pounds of metal to vital industries during 1941.

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GUNGA DIN

Now Plays His Role in Modern Industry

For dispensing water in a sanitary manner, on defense construction jobs and in factories, a new mobile water tank unit has been developed by Universal Paper Products Company. These units eliminate the dangerous "germ-exchange" bucket and dipper method of dispensing water—a method which is actually prohibited in all but three states, but which has crept back into practice unnoticed, in the drive for increased defense production.

In tests it was found that the new water tanks are definite time-savers. Where workers were spending from 5 to 10 minutes going to and returning from stationary drinking-water dispensers, these mobile units eliminate the valuable waste time

Industry's Gunga Din

Tanks are made in two models. One can be carried on the back, and the other at the carrier's side. Both are made from lightweight metals and have adjustable shoulder straps, a paper cup dispenser, and standard faucet. A large mouth allows quick filling and easy cleaning. Both models can be had with a sturdy canvas jacket that has a hair-felt lining which serves as both insulation against hot and cold, and as a padding for the carrier's comfort.

MORE WORK

From Existing Tools to Increase Production

In a single airplane engine there are often 900 different parts; counting duplicate parts, a total of more than 8000 pieces of metal. And with the exception of the rocker arms, every fraction of every square inch of these pieces must be machined. In producing a single 75mm shell and fuse there are more than 100 separate machine operations. There are 3390 separate machine operations on the parts of a .50-caliber machine gun. Production of an aircraft engine may involve as high as 45,000 separate operations on machine tools.

These illustrations are typical of the defense program as a whole. The volume of machine tool work in defense industries is enormous. Expanding machine tool output is a very different proposition from expanding output of a single article, such as a lawn mower.

In size, machine tools range all the way from that of a sewing machine to that of a two-story house. In cost, they range from less than $50 to over $50,000. Machine tools must be designed to do the particular job for which they are to be used.

Therefore the machine tool industry could not use the principles of mass production. Machine tools, on the whole, have to be built to order, and this takes time.

If every machine tool operator of this country would step up his output by 10 percent, the result in increased performance would be the equivalent of a whole year's production of new machine tools.

Of course, we can attack the situation from a more wasteful point of view. We can build dozens of new plants, train thousands of new men, sub-contract more extensively. But all this takes more money, and what is still more important, it takes more time. Certainly it would seem vital at this particular juncture to make an "all-out" effort to get maximum productivity out of existing machine tools. With that behind us, we would then be in a position to know concretely how many more machine tools, how many more new plants, and how many more new men would really be required. —*Charles J. Stillwell, president of the Warner & Swasey Company, in* The Clevelander.

HARDENED STEEL

New Process Recalls Fame of Damascus Blades

A new method of hardening the surface of steel by the use of synthetic urea was described recently by Ray P. Dunn, research metallurgist of the Electro Manganese Corporation; W. B. F. Mackay, flying officer, Royal Canadian Air

Force; and Prof. Ralph L. Dowdell, professor of metallography, University of Minnesota.

The use of synthetic urea as a source of nitrogen in the "nitriding" of steel was investigated because it is cheap, easy to handle, can be obtained in commercially pure crystals, and gives off ammonia gas, a compound of nitrogen and hydrogen, when heated to 270 degrees, Fahrenheit.

This process brings to mind the famous Damascus blade of medieval times, which is said to have been surface-hardened by the use of camel's dung. If so, these early artificers were unwittingly applying a crude form of the modern process of nitriding steel.

The present investigators tested their process on small specimens of three types of steel, using different furnace temperatures to ascertain the best conditions. Hardness tests on the nitrided specimens showed that high commercial hardness can be obtained with the urea method and the conclusion was drawn that the method has distinct commercial possibilities.

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REFLECTORS: Silvered glass reflectors are being used to replace highly polished aluminum reflectors in the pendent type street light manufactured by one large electric company.

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RESEARCH MILLIONS

New Record Set For Expenditures

Breaking their own records for spending millions to develop new American-made products, manufacturing industries throughout the country invested $117,490,000 into research during 1941 for America's future.

Contrary to the wide belief that big companies do all the research work, little and medium-sized companies spend relatively as much as big companies on experiments and tests and inventing, Robert I. Lund, chairman of the National Association of Manufacturers' committee on patents and research, reports as the result of a study of 1008 firms, conducted by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology.

Only 8 percent of the companies reporting research outlay said that they are spending less than in 1940, while 43 percent said they are spending the same as in 1940, and 49 percent are spending more. Companies with research programs averaged more than $116,000 per company last year.

"Here is tangible evidence of industry's faith in America's future," declared Mr. Lund. "In industrial research lies the great hope for re-employment, for productive application of savings, and for the beneficial utilization of war production plants."—*Science Service.*

DRAFTING BOARD

Cranks Up and Down, Provides Comfort

An engineering drafting board which cranks up and down is a new development of the engineering department of The Glenn L Martin Company Taking a load off the feet and stomachs of the men who have spent most of their lives standing or leaning over tables, the new board now seats them comfortably in swivel chairs.

When not being used, the board lies flat on its desk-top. The draftsman, seated in his chair, twirls a small window-type crank which raises the board to the desired level. Then, by means of a horizontal bar, beneath the edge of the board, he adjusts it to the proper angle. The board is kept in firm position by a "dog," controlled by the bar, which drops into a notched locking sector. These tables are set in parallel rows so that the draftsman uses his own adjustable table for drawing and with but a half-turn of his chair has immediate use of the desk half of the combination table behind him.

Less clean-up time required

Draftsmen, who for many years endured the strain of being on their feet all day at the old tables, like the new invention and contend that they accomplish a considerably greater amount of work and with noticeably less fatigue at the end of a long day.

Another advantage of this tilted drawing surface is the greatly diminished amount of soiling due to perspiration and the rubbing in of pencil dust, as the draftsman stretches and reaches across his work. This in itself is quite a time-saving factor as finished work requires less cleaning-up.

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NAILS—Five tons of nails—100 kegs weighing 100 pounds each—are used every day at the Windsor plant of the Ford Motor Company of Canada in crating military vehicles for shipment to the British armies overseas.

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REFRIGERATION

Has Many Uses, Even in Defense

Of course refrigeration will keep vegetables and meats from spoiling and occasionally give you the shivers when you enter a really air conditioned room on a hot day. But what about these less usual cases. Iced cookies are kept firm, do not stick together. Coffee is kept fresh. Bread and pastry are kept from molding. Sugar and salt kept in the refrigerator do not get lumpy. Cigars are kept in good condition. Cosmetics do not get soft and oily. Medicinals such as cod-liver oil and mineral oil if well chilled show a reduction of odor and taste intensity and are more palatable. Even a young lady reports that her angora sweater does not rub off on her boy-friend if put in the refrigerator for a couple of hours before wearing.

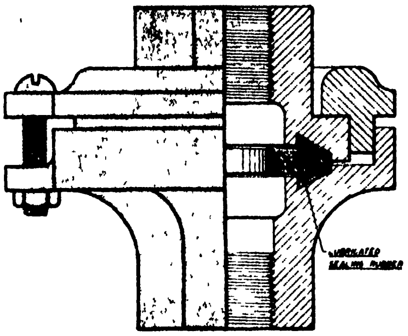
Refrigeration even has its place in the defense program, and not only to chill soft drinks and provide ice cubes for more authoritative beverages. Mercury fulminate is the detonator which sets off the charge of powder in a cartridge and of other explosives in shells. As one may imagine from that use it explodes pretty readily and isn't manufactured in the center of any of our large cities.

An explosion is a chemical reaction, therefore is slowed down with decrease in temperature, generally lessened in rate by one-half for every decline in temperature of 10 degrees, Centigrade. So mercury fulminate is stored in refrigerators until ready to be used, as a means of increasing safety in handling it.—*The Chemical Digest.*

LEAD LUBRICANT

Combined In A Rubber Gasket

The lubricating qualities of lead are serving a useful purpose in a new type of swing joint for low-pressure steam lines developed by the Patterson-Ballagh Corporation. The secret of the efficiency of the joint lies in a rubber gasket, into which powdered lead is milled before the gasket is shaped.



Powdered lead in rubber gasket

Because of the lubricating action of the lead, it is claimed that the new joint turns more freely under pressure than other types and that the lead lengthens the life of the gasket.

As the cross sectional drawing herewith indicates, the lead-rubber gasket is specially shaped to insure a tight seal and at the same time provide flexibility to the joint.

The swing joint, which handles steam pressures up to 100 pounds, is designed for use on moving machines or equipment which are connected to stationary steam lines. Typical applications are steam lines on rubber molding and chemical equipment.

AND NOW SHELLS

A Long Step From Automatic Pencils

Mass production methods, as devoloped by American industry, are being effectively applied to the manufacture of war materials for the national defense program in hundreds of factories, large and small. Most of these plants had been making articles for peacetime consumption. Now they have converted many of their machines and tools for the production of instruments of war.

An interesting example is the case of Paul Hauton, consulting engineer, who gathered a group of young engineers, 18 years ago, and organized the Scripto Manufacturing Company in Atlanta, Georgia, which today produces from 13 to 15 million automatic pencils a year. These pencils are sold throughout the world for ten cents or the equivalent.

When the national defense program got under way, Scripto was given an order to make two million brass boosters for artillery shells. Engineers estimated that by working 24 hours a day, 1000 men could produce 10,000 boosters a week at a cost of from $1.75 to $2.50 each. After months of designing gages, making tools, and building machinery, Scripto was ready to begin production. With just 150 workers Scripto turned out tens of thousands of boosters a week, and they only cost the Army 55 to 75 cents each.

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TRUCKS: One out of every twenty trucks operating on the highways of United States is owned and operated by local, state, or federal government units.

• • •

HIGH GLOSS

Liquid Plastic Used in Printing Process

A high-gloss surface applied over any type of printed matter on heavy paper or cardboard, and which is designed to replace present varnishing and other methods, is simply achieved with a machine which applies a molten coating of plastics either over the printing for enhancement or as a protective interior coating.

The plastic material used is reduced to liquid form by heat, there being no solvents or liquid carrier used. Hardening of the film is obtained by chilling alone, eliminating any drying or racking, the piece is finished when it leaves the machine

The plastic is put into a heated tank or reservoir, from which it is picked up by an application roll, which in turn is doctored to give the proper coverage. A pressure roller is adjusted by adjustment screws and from this point the piece is carried between polishing rolls which are adjustable for the weight and character of the sheet. All heated parts are thermostatically controlled to operate at varying temperatures, depending upon the coating material used.

The chemicals used in the process, developed by Bert C. Miller, Inc., are specially formulated materials to give the desired characteristics to the particular job. For example, where an extremely high gloss is desired, with full flexibility at the folds, one material is used; should a very high degree of greaseproofness be desired, another material may be used. The range of materials is quite wide and designed to cover most any requirement.

Over-printing with plastic

When box blanks are coated they may then go directly to the gluing machine, but special glues for holding on waterproof surfaces are necessary.

WELDING

Experiments Shed Light on Effect of Rod Temper

"Results of extensive welding experiments with rods of nickel, Monel, and Inconel, in which the nature of the wire was varied from the soft, fully annealed to cold drawn hard tempered condition, proved that the condition of temper of the core wire had no effect on the resulting weld " This statement was made by F. G. Flocke and K. M. Spicer, welding technicians of the International Nickel Company, in a paper entitled, "A Study of the Effect of Core Wire Temper on the Quality of Welds in Nickel, Monel, and Inconel," presented before the Annual Meeting of the American Welding Society.

INDUSTRIAL TRENDS

MOLYBDENUM LOOKS UP

TUNGSTEN, nickel, vanadium, chromium, and molybdenum are five elements that hold places of importance in the steel industry; they are used in varying proportions in steel alloys to produce resulting metals that have characteristics which fit a wide variety of purposes. Yet of these five elements, molybdenum holds a unique advantage over the other four. It is the only one of the five that is currently produced in sufficiently large quantities in the United States to meet present needs. In the case of the other four, relatively large quantities must be imported to supplement our own supplies And, at the time of writing, it appears that at least two of these needed alloying metals will be available in even smaller quantities than in the recent past, much of our chromium comes from the Philippines and of our tungsten from China.

The properties which molybdenum impart to alloy steels include an increase in the elastic limit of the metal and in resistance to impact and other stresses "Moly," as the element is frequently called, is also used in the manufacture of stainless steels.

Molybdenum may be used alone in producing high-strength steel alloys or in conjunction with one or more other alloying metals. Now, in view of the decreasing supplies of some of the other ingredients of alloys, and even complete unavailability in some cases, it is no matter of wonder that increased attention is being given to research directed along the lines of finding the best ways of getting the most advantageous results with this relatively plentiful element. It is no secret that these researches are successful in many respects and that new uses being found for moly will find permanent places in industry. When the world returns to normal, and other steel alloying elements once more become available, they will find moly well up on top of the pile, doing jobs that they used to do and in many cases doing them just as well and just as economically or better and cheaper.

CORK FACES TROUBLE

DESPITE continuing endeavors to grow satisfactory cork trees in the United States, particularly in southern California, the supply of commercial cork still comes from countries bordering the western Mediterranean. It is thus obvious that those industries in the United States which require cork for any purpose are facing a production problem of no small moment

Of the 150,000 tons of cork normally consumed each year in this country, some 70 percent goes for insulation purposes, 16 percent to crown corks and gaskets, 8 percent to linoleum, and the remainder to life preservers and other cork products including solid corks for bottles, according to *Barron's*

Let's get some of these uses down on their backs and examine them in the light of possible alternate materials, thus getting a view of the possible trends which must result if our cork supply is cut off or even drastically reduced.

Insulation: The tiny air cells in cork give the material its outstanding insulation properties. But glass wool, rock (mineral) wool, and many wood and other vegetable fibers have similar properties and can be produced in large quantities.

Crown corks and gaskets: These two products use cork in thin sheet form. Several forms of synthetic rubber are possible alternates in these fields, as are also other substitutes, all of which have the disadvantage of higher cost, but the advantage of availability. Gaskets, used in internal combustion engines, stand the best chance of continuing to be made of cork as long as any of the material is available.

Linoleum: Very little cork is used in present-day linoleum, except in the heavy-duty types. Advances in the linoleum industry have produced many satisfactory substitutes long before the exigencies of war made them necessary. Thus there is already a foundation for production of all needed linoleum without cork

Life preservers Balsa wood and kapok are logical substitutes as long as they can be obtained. Then there is the inflatable type, already in wide use, which depends on carbon dioxide to furnish flotation.

Solid corks: Many whiskey, wine, and other liquid containers are now being sealed with metal and composition screw caps using inserts similar to those in crown caps, placing this problem in the same category with crowns, if and when the cork shortage forces all bottlers to turn to this type of closure.

All in all, it does not seem that the cork situation is so serious that it cannot be met by ingenuity, although it will undoubtedly mean serious and expensive readjustment throughout the industry.

WHAT ABOUT THE WAR?

WHEN "Industrial Trends" was first inaugurated as a feature in Scientific American, its purpose, which is still being pursued, was to acquaint readers with those phases of the progress of science and industry which, because of their partly speculative nature, could not always be treated by the straight reporting technique which pertains in the rest of the magazine.

Now we have come to an important crisis in world events At the time of writing, the flames of war have scorched American possessions, continental United States is rapidly preparing to face possible invasion, every effort has been turned toward production of those military and naval materials that are essential to the protection of our country and the successful waging of war against aggression.

Still the trends of industry remain of outstanding importance. Higher production speeds are being gained in many lines, new and better methods are being developed under the pressure of necessity. And out of the lessons that industry is learning are coming the trends of peace-time production—new materials, improved processes, industries based on products heretofore unknown.

More than ever, then, it is essential to keep an eye on the rapidly changing picture of industry if trends are to be projected into the future when human beings turn from Mars to Mother Earth and once more take up their normal lives.

—*The Editors*

Stellar Advertising Signs

Neon, So Rare on Earth, Proves to be 1000 Times More Abundant in the Stars

HENRY NORRIS RUSSELL, Ph.D
Head of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE average citizen knows more about chemistry than did his predecessor 50 years ago — at least about the names of things and some of their properties. In those days chromium was known to most folks, if at all, as a constituent of certain paints. Now its appearance is so familiar that we talk of the "chromium-plated" type of architecture. But a little longer ago, aluminum was a costly curiosity — now it is even more important in defense than in the household.

A list of all the elements which have passed from the unfamiliar to the familiar would be fairly long. Some of them, like the two just mentioned, occur in great quantities, and owe their changed economic status to the development of practical methods for producing and utilizing them. Others, like tungsten, are rare but have found important technical applications. Should we ask what is the rarest element which is now utilized in a manner familiar to everyone, the answer must, of course, be radium — whose use in luminous paint depends on its most distinctive property. Next to this comes neon, which is unique in being commercially valuable solely for its spectroscopic properties. Like all other gases, it can be set shining by a high-tension discharge; but no other gives off light of such esthetic appeal.

Argon has a spectrum exactly like neon in structure — they can be matched line for line — but the argon lines corresponding to the great group of neon lines in the red are in the infra-red, or so near it that they are hardly visible, so that an argon tube shines with a feeble purplish light (compounded from fainter lines in various parts of the visible spectrum) and has no advertising value.

Neon forms 1/55,000 part by volume, or 1/77,000 by weight, of the atmosphere, which itself has only a millionth part of the weight of the whole earth. It was formerly supposed that neon, which does not combine chemically, must be absent from the body of the earth; but Lord Rayleigh, after a very careful investigation, found that igneous rocks contain, on the average, one cubic centimeter of neon in 12 tons, or one part in 14 billions by weight.

These are, of course, surface rocks. No one knows whether the deeper rocky part of the earth contains the same proportion. If it does, the whole amount of neon trapped in the solid body of our planet comes out four times that present in the atmosphere. On this admittedly uncertain basis, it appears that neon accounts for only about one ten-billionth part by weight of the whole earth.

IN THE atmosphere, argon is 520 times more abundant than neon by volume, and very nearly 1000 times by weight. Rayleigh finds about 500 times more argon than neon in the rocks.

Most of the elements which we call "rare" are far more abundant on earth than neon. In the surface rocks (which alone can be analyzed), there is one part in ten millions of silver and one in 200 millions of gold or platinum. The rarest of the "rare earths" are more abundant than silver.

If neon was as rare in the heavens as on earth, we could not expect to find perceptible traces of its lines in any spectra — but in some cases they are conspicuous. Lines of neutral neon — the very ones which make neon signs so conspicuous — appear in absorption in the spectrum of stars like Rigel, and lines of ionized neon in hotter stars. The gaseous nebulae, too, show neon lines in their spectra (forbidden lines, as in the case of other elements). Some lines of argon have been observed, both in stars and nebulae, but these are fainter, indicating that the relative abundance of the two gases is reversed.

From measures of the widths of the absorption lines in good stellar spectra, the relative abundance of the elements which produce them can be determined. An attack upon this problem was made just before the war by Unsöld, a first-rate German astrophysicist, using spectra taken for the purpose at the McDonald Observatory in Texas. The hot star, Tau Scorpii (next to Antares on the left), proved especially well adapted for this study, as its spectrum is full of sharp lines. A few copies of the resulting paper have reached America. The methods of calculation, some of which are new and very ingenious, need not be described here; but the results are of great interest.

LINES of only a few metals were observable, but these are among the most abundant in the Sun and the cooler stars, and afford a connection with our previous knowledge. Magnesium and silicon are about equally abundant (as in the Sun) and ten times more so than aluminum. Taking these two as a standard, the amount of carbon, by weight, is approximately 1½, of nitrogen 3, of oxygen 10, and of neon 15. Neon is the most abundant element (whether by weight or number of atoms) except for the lightest of all — the amount of hydrogen by weight being 600, and of helium 450.

The enormous abundance of hydrogen has long been known, and that of helium anticipated — though these are the first numerical data. But the high abundance of neon was unexpected. The evidence in its favor is fully convincing, and any surprise at it is only one more indication how much our terrestrial experience subconsciously influences our thinking.

It will be of great interest to test the relative abundance of neon and oxygen in other stars which show the lines of both, and this will doubtless be done before long. But it is highly improbable that the conclusion that neon is among the most abundant of all the elements after the first two will be upset. We need not worry about the Sun, for a simple calculation shows that, at its low temperature, even the strongest neon lines (being absorbed only by highly excited atoms) would not show unless it was very much more abundant than oxygen.

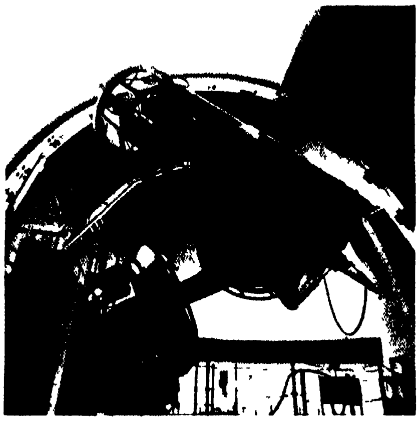
But the extreme rarity of neon on earth urgently demands some explanation. There is at least a billion times more oxygen than neon on our planet. How could such a tremendous difference have arisen?

The answer is not really far to seek. The relative proportions of the heavier elements, from sodium onward, are nearly the same in the Earth and the Sun. In several cases, when previous estimates of the abundance in one or the other have been corrected on the basis of better evidence, the agreement has been improved. In other words, the relative proportions of all those elements which form compounds that are solid or liquid at the temperature of molten rock are nearly the same, while those elements whose compounds are gaseous at such a temperature are much less abundant on the earth

This is exactly what might be expected if the material which now forms our planet had condensed out of a cooling, but still hot, gaseous mixture similar in composition to the Sun or the stars. Just as rain drops or snow flakes form in moist, cooling air — although water-vapor forms but a small percentage of the whole — compounds of high melting and boiling points would condense out of the gas With hydrogen present in large excess, the more easily reducible metals, including iron, would separate out wholly or partly in metallic form. Difficultly reducible metals — magnesium, aluminum, calcium, sodium, and also silicon — would combine with oxygen, and condense into a silicate magma Large quantities of oxygen would thus enter the melt, and smaller quantities of carbon, or even of nitrogen, might be included; but helium, neon, and argon could at best be dissolved by it, probably in very small amounts, and the great excess of hydrogen would remain free.

SPITZER'S investigations (reported on in these columns in March, 1940) show that such condensation would not occur in a "filament" of matter stripped off by the collision of two stars; but they do not prove that condensed droplets, or large masses, could never be formed under any circumstances. The composition of our planet affords the best reason for supposing that, at some time and in some way, it *was* so formed

OUR planet is now surrounded by vast empty spaces, hence it must have escaped from the gas-cloud which is here postulated When it began an independent existence, it was presumably very hot even at the surface. It may have carried with it some of the lighter permanent gases; but hydrogen and helium would rapidly escape and, if it was hot enough, neon would escape too, and also water-vapor and nitrogen, so far as the N_2 molecule was dissociated into atoms The probable later history is familiar. The dense metal sank to the center, where it still forms a liquid core. The silicate mantle, 1800 miles thick, gradually solidified, beginning at the bottom, where the pressure raised the melting-point As it froze, great quantities of water-vapor and other gases were released, which rose to the surface — now not hot enough to admit of the escape of these gases against gravity — and formed a great atmosphere, mostly of steam. When the surface grew cool enough, the water of the oceans condensed, leaving a permanent atmosphere



The great 80-inch telescope at McDonald Observatory, where the work described was done

The oxygen in our present atmosphere may be accounted for by decomposition of carbon dioxide by plants since life began. The nitrogen, neon, and argon must have been there before the oceans condensed. Whether they were there before the great lava-mantle froze is uncertain.

Rayleigh, in the work mentioned above, found that there is a small, but easily measurable, amount of nitrogen in ordinary rocks, amounting to about 1/200 of one percent by weight. On this basis, the rocky mantle still contains 50 times as much nitrogen as the atmosphere.

The nitrogen in the rocks is, at least in part, chemically combined, and is converted into ammonia by heating with alkali. This important discovery makes it entirely possible that the nitrogen of the atmosphere is not primitive, but was liberated by physico-chemical processes during the solidification of the rocks.

Oxygen accounts for nearly half the weight of the rocks, and is about 10,000 times more abundant than the nitrogen — while in the stars the difference is the other way This difference may be taken as a measure of the average relative affinity (to use an old word) of the rock-forming metals for the two elements

Similar reasoning about neon and argon would have to start with some assumption how they got into the rocks At present, as Rayleigh suggests, they are probably trapped, an atom here and there, in the lattices of atoms composing the crystals. Whether they were previously dissolved in the molten silicates, and, if so, how much would have been set free on solidification, is a question on which the present writer has no data. Until more is known, it is hard to be sure that any constituent of the present atmosphere consists mainly of gas which was in the original atmosphere of the liquid planet.

ONE puzzle still remains. Lines of argon have been identified in the stars and the nebulae, but are weaker than those of neon, and it seems quite safe to conclude that argon is less abundant than neon, cosmically speaking. We must await measures of the intensity of the argon lines to find out how much less abundant it is. But it is clear that neon is at least a thousand times more abundant, compared with argon, in the stars than in the Earth's atmosphere. Rayleigh finds the same to be true for the gases in igneous rocks. Whether this means that the rocks got these gases in some way from the atmosphere, or that the original molten rocks in some strange way dissolved argon a thousand times more readily than neon, no one can say.

It is stimulating to have some things left for future discovery.—*Princeton University Observatory, December 5, 1941*

Ancient Ostia

Ignoring Present-Day Strifes, Archeologists Unearth Rome's Once-Thriving Seaport

ALINE ABAECHERLI BOYCE
Fellow of the American Academy at Rome

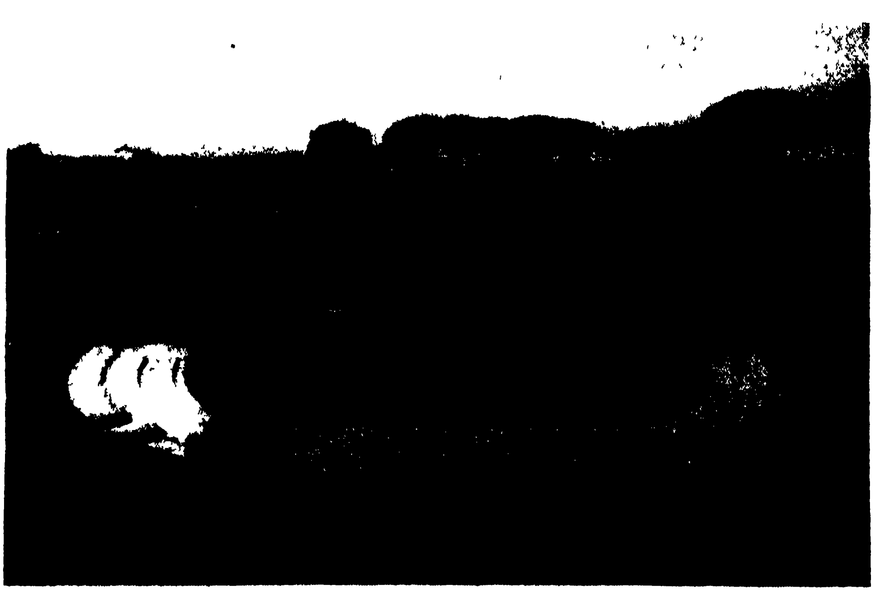
FIFTEEN miles west and slightly south of the city of Rome lies the mouth of the River Tiber, where, according to legend, Aeneas, the founder of the Latin race, disembarked at the end of his long journey from Troy after the fall of that famous city. On this spot, it is said, was founded the ancient town of Ostia, in historical times the seaport of Rome. Archeological excavations, however, have indicated that the town actually goes back only to the 4th Century B.C., when Rome sent a military colony to garrison the site. Thereafter, Ostia became a distributing station for grain, and grew and thrived until, in imperial times, it was an emporium of 100,000 inhabitants, many of whom were foreigners from across the seas.

The excavations that have been going on there have revealed the town chiefly in its period of greatest prosperity—from the 2nd to the 4th Century A.D. The "dig" at Ostia is a project of tremendous importance to archeologists all over the world. Ostia has been undergoing scientific and systematic excavation since 1909, but has recently been uncovered on a large scale in sections previously almost untouched by the spade of the archeologist. For years the excavation has been under the direction of Professor Guido Calza, who has brought to light market buildings, apartment houses, shops, paintings, sculpture, mosaics, and inscriptions that equal, if they do not surpass, important finds of previous campaigns.

TO STATE the problem of excavation simply, we have at Ostia a city of the imperial period—that is, the middle of the 1st Century B.C. to the 4th Century A.D.—superimposed upon a city of the Roman republic (4th Century B.C. to 1st Century B.C.). The republican remains must be studied without destroying the younger and therefore higher imperial city, and the imperial city must be reconstructed safely and accurately.

Ostia, like Rome, suffered much in medieval and modern times from pillage for marbles and other materials, and parts of buildings and statues not previously carried off must be excavated and reconstructed with painstaking care. To quote Professor Calza: "In these works of restoration and reconstruction an attempt has been made to create the most complete picture possible of the ancient buildings, putting back the fragments found in excavating into their original places, which have previously been scientifically ascertained. . . This has also been done to some of the painted ceilings and mosaic floors fallen from above, which have been raised and replaced on their original level. . . Sometimes, in order better to preserve the paintings, we have protected some of the rooms either by restoring the original vaulted roof or by making a wooden covering."*

The elegant granary in Ostia



The view from the top of the ancient theater (see the text)

The buildings lie chiefly on either side of a main street, or *decumanus maximus*, which leads from the entrance of the excavations toward the lower reaches of the Tiber. On the bank of the Tiber, opposite Ostia, lies a cemetery of imperial times, which contains the tombs of artisans or engineers connected with the later artificial harbor of Porto—tombs which are striking because of the handsome brick design which adorns their facades. Between this cemetery and the river on the one hand, and the previously excavated parts of Ostia on the other, lie the newly excavated sections, which spread out from the main street in all directions. Within the last five years the size of the excavated portions of the city has doubled, and it is indeed a large town of imperial Rome that the archeologists now can look upon.

Like many cities in ancient Italy, Ostia was surrounded by a wall constructed of large blocks of tufa, a volcanic stone. Before the

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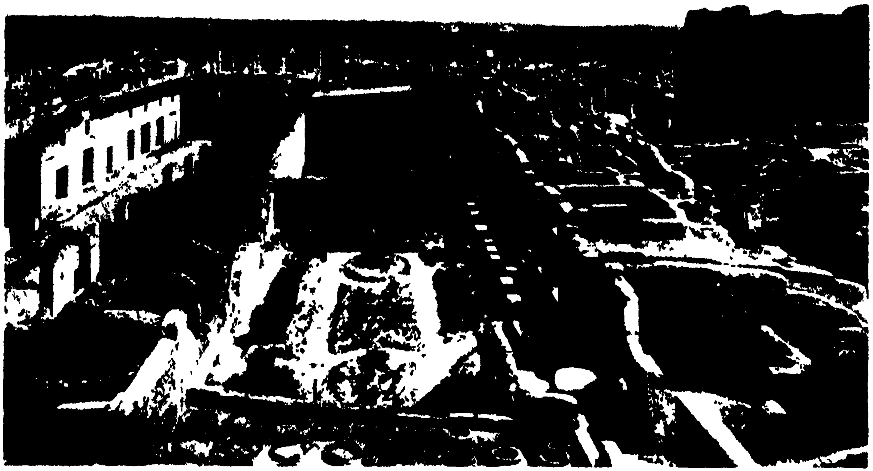
*G Calza, *Ostia, Historical Guide to the Monuments*, translated by R Weeden-Cooke, Milano, 1926, pp 77-8



In the foreground are big storage jars and a garden, while in the background are the archeologists' excavations in the vicinity of the forum

city wall was built there was a small *castrum*, or fortification, which goes back to the earliest history of the settlement, probably the 4th Century B.C The gates of the castrum and considerable portions of the city wall have been found, though most of the remains are below the ground level. Before passing the foundations of a city gate near the entrance to the excavations, one must walk along that section of the main street which is lined with tombs of various levels and types There are republican tombs at a lower level, with imperial burials above them; there are *columbaria*, or dovecotes, which held cinerary urns, and there are sculptured sarcophagi indicating inhumation, or interment, burials. Here and there an inscription gives the name and trade or official position of the dead.

STREETS lined with tombs, just outside the city walls, are a common feature of ancient cities. The Via Appia, leading south from Rome, ancient Rome's first great military highway, is perhaps the most famous example of such a street, though other roads leading from Rome were lined with tombs. Similar streets exist in Pompeii, and tombs were found on the outskirts of Ostia, the best preserved being the brick-faced tombs on the "Sacred Island" across the Tiber

In the city proper, along the main street, which is crossed at intervals by minor streets, lie baths, warehouses, police barracks, temples, and a theater. From the top of this theater one obtains an excellent view of some of the excavations now in progress—a view shown in one of the illustrations Beyond the theater lies a large rectangular open space, green with long, straggling grass, in the center of which stand the remains of a temple, consisting of the podium, stairway, and two columns of the porch. The remains of a colonnade surround the open space and behind the colonnade on three sides are traces of the offices of transport and merchant guilds from many towns of the Roman empire. The names of some of the guilds, together with the names of the towns and the symbols of the guilds which they represent, are still to be seen on the black and white mosaic floors of the offices. For the economic history of Rome these inscriptions in mosaic are of great interest. As one might expect, the rear of this enclosure lay close to the ancient course of the Tiber, which has since changed its direction.

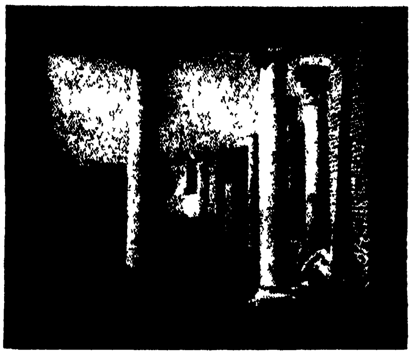
On the main street, opposite the theater, are some of the new excavations of large public buildings, and on lesser streets are apartment houses and warehouses. One of the latter, shown in a photograph, is a granary, but it has a fine entrance and a handsome courtyard which anticipate in architectural style the palaces of the renaissance. In several storehouses, one of which has recently been excavated, and which also is illustrated here, can be seen immense earthen storage jars.

The apartment houses of Ostia are of interest because they, too, provide a precedent for renaissance and modern Roman houses, and because they are in direct contrast, moreover, to the suburban style of ancient house with leisurely atrium and peristyle, which is the dominant type in Pompeii At Pompeii one occasionally finds a staircase leading up to a second story. At Ostia the apartment houses had several additional stories, and sometimes on the upper floors there were balconies reminding one of the balconies on apartment houses in the Rome of modern times.

FARTHER along the main street one begins to realize from the freshly uncovered appearance of the bricks that he has entered a newly excavated section—from here on all of the excavations are new. There appear two charming shops —a fish market with a marble table for wares, and a mosaic floor with fish outlined in black tesserae, or little black squares; and a second shop with a marble, rectangular basin surmounted by two thin, graceful columns Of the shops throughout the old and new excavations, not the least interesting are the bars, or *thermopolia;* that is, "hot-drink shops." Some of the little wine-shops in Rome today bear a strong resemblance to these *thermopolia.*

One of the prettiest buildings in the new section has a dining room with marble-encrusted walls and a multi-colored marble floor, beautifully reconstructed from the ancient marbles found on the spot This room is entered from a *nymphaeum*, or fountain room. Here, on one side, water flowed from the wall over thin slabs of marble

Portrait bust of Themistocles



4th Century Christian basilica

overlapping in the style of our slate or tile roofs. Below, there emerge some pipes, probably showing that water also flowed from terminal heads of fish or animals such as often provide the inlets for our modern swimming pools. In the background, a columned arcade, comparable in style to renaissance loggias, forms the only surviving decorative feature of the fountain. In the foreground, a small plot of grass touches off the scene, and one can well imagine that it was a handsome and lively fountain that some wealthy citizen of Ostia built here

IN GENERAL, the streets at Ostia are laid out according to a very regular plan. But among the recent excavations there lie close together three temples whose orientation is quite haphazard. All these temples show, at a lower level, platforms which, perhaps, go back to the 2nd Century B.C The largest of them has a dedicatory inscription to the god Hercules.

The new excavations have brought to light many interesting pieces of sculpture—statues, portrait busts, and reliefs. The most recent finds are placed in a large vaulted room of one of the ancient buildings. One of these is a large statue of the oriental god Mithras slaying a bull, a common Mithraic motif. Shrines of Mithras are always turning up at Ostia. There are also in this room a statue of the emperor Trajan wearing a cuirass of unique style, a portrait bust (see photograph) inscribed "Themistocles," the curious nature of which has given archeologists some trouble; also, reliefs of shop scenes, and a relief possibly representing the birth of Minerva from the head of Zeus. A small permanent museum houses the sculpture, inscriptions, and small objects previously found. Of the inscriptions, the fragments of a Roman calendar discovered a few years ago are the most important. There also is a fine collection of portrait heads

The most spectacular event occuring at the dig was the discovery of a 4th Century Christian basilica on the north side of the main street (see the illustration). This building had a vestibule with an entrance formed by two arches, a type which one naturally compares with old churches in Rome having porticos The features of chief interest in it are a baptismal basin and an architrave on which are inscribed the Christian monogram and the names of four Biblical rivers, including the Tigris and Euphrates. The basilica has two apses and two naves separated by a row of columns, and on the eastern side there are several rooms that must have been side chapels.

The last chapter of imperial Ostia's history was not a spectacular one, when compared with that of Pompeii, a city which was completely lost in one of the world's major catastrophes, and the recovery of which has therefore been widely publicized. For Ostia was never completely lost, but suffered a gradual and pathetic decline as the result of neglect and plunder Early in the imperial period the first artificial port was built at the mouth of the Tiber to replace the port of Ostia, which was no longer adequate to handle the volume of trade between Rome and towns beyond the seas, but it was not until the reign of Constantine the Great, in the 4th Century A D., that this new port was favored so completely as to exclude Ostia entirely from commercial traffic between Rome and the sea. The more interesting is it, therefore, that in this period of the city's decline a Christian basilica of considerable size was superimposed on remains of pagan buildings.

Not long after the erection of this church, Ostia became associated with one of the great figures of church history, for it was to this town that Saint Augustine came with his mother, Saint Monica, to take ship for his home in Africa after his conversion. Saint Monica never sailed, for here —as Augustine tells us in the ninth book of his *Confessions*— after nine days of illness, she died. Her death took place in a little inn overlooking a garden. Such a garden one may see today in Ostia, giving warmth and life to the ancient bricks and mortar that surround it. Archeologists like to think that now they may look upon the garden of the little inn where the devout Monica spent her last days, and they like to think, too, that perhaps the saint and his mother stopped and worshipped in the little church which still stands there.

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FOSSIL

World's Oldest Evidence Of Animal Life

EARLIEST known record of animal life on earth may be the fossil imprint of a stranded jellyfish on a slab of fine-grained red sandstone now in the geological collections of the Smithsonian Institution. It came from pre-Cambrian deposits at the bottom of the Grand Canyon of Arizona, which are more than half a billion years old.

Dr. R. S. Bassler, head curator of geology at the United States National Museum, states that the imprint has all the appearance of having been made by a jellyfish. It resembles jellyfish fossils of Cambrian age, earliest period from which animal remains are at all numerous. It also resembles the dried-up stranded jellyfish washed ashore on modern beaches. There are ripple-marks, as of an ancient beach, on the Smithsonian specimen, and the lobed structure of the animal is impressed on these.

Pre-Cambrian rocks are singularly empty of traces of animal life, despite the high probability that the earth had inhabitants at that remote time. During the Cambrian age, which began about 550,000,000 years ago and lasted 70,000,000 years, there were abundant animals, representing practically all of the major zoological groups except the vertebrates. This argues that a long period of evolution must have preceded the Cambrian. But for some reason (possibly the lack of lime in the waters of those days) they have left no shells or other hard parts by which they could be recognized. Hence the great scientific interest of the jellyfish markings on the ancient stone slab.—*Science Service.*

No Mystery In Pep

Seven Simple Rules for Getting and Maintaining a Reserve of Vigor

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DO YOU have more horsepower than you need for the day's activities?

Your automobile quite likely has much more horsepower than is usually used. This is reserve power, power which gives it pep. Some energetic people, also, have more energy than they use up and can finish the day with as much pep as they began it.

The chief source of this human horsepower, this reserve of vigor, comes from protective eating. Everyone understands the importance of foods, but few realize the relationship which exists between what they eat and how vigorous they are. Those few who are aware of the influence that the daily foods have on one's daily pep, often go off on a tangent; they become food faddists, and try to subsist on some fearsome combinations, such as honey and clabbered milk. Or, they hear about some fanatical, but impressive, dietary cult, and religiously follow its leader, avoiding combinations of food which he claims are harmful.

It is a scientific fact that these dietary cults, almost without exception, are injurious to vigor and pep. Yet human nature seems to like to embrace all kinds of new and silly fads, instead of old, monotonous, scientific truths. I think one reason for this is the ease with which a fad can be remembered — avoid carbohydrates and proteins at the same meal, to quote from one cult. Now that surely is easily remembered and easy to practice, but it has no scientific merit.

Scientific rules, in contrast, are usually complicated, loaded with chemistry and strange weights, and completely bewildering to the average person. Protective eating, however, can be reduced to simple rules, which require no chemical knowledge, and do not tax the memory. In this article we shall take up rules for protective eating, or *Rules for Getting a Reserve of Vigor*. These rules will be reduced to such simple and essential terms that any average adult can remember them, and follow them with little effort, and then can learn to conserve the same vigor after getting it.

Rule 1: Eat three different vegetables a day

In this era of highly refined, ready-prepared foods, quick lunch sandwiches at the soda fountain, nine people out of ten do not get sufficient vitamins and minerals in their daily food. The vigorous pioneers of a century ago got a more adequate supply of vitamins and minerals than do their pepless descendants of the present day. Even the prisons and almshouses of the 17th and 18th Centuries, dismal and unsanitary as they were, served food which made for more vigor than the wealthy get in their luxurious clubs today.

Moderns need to watch carefully to make certain that they get three different vegetables a day so that they may keep up a reserve of vigor. The vitamins and minerals give a little extra horsepower, which is sorely needed by almost everyone. (Potatoes, whether white or sweet, do not count in this discussion, as vegetables.)

The vegetables do not need to be fresh; canned will do just as well. They can be in soup. They can be raw, or cooked, or warmed over. It is not complicated — just remember three different vegetables a day, in addition to potatoes.

It is helpful to have one of the vegetables of the leafy variety, such as lettuce, cabbage, broccoli, or even spinach.

Some time ago a 35-year-old advertising man who had suddenly found himself making big money, confessed to me privately that he felt himself slipping. He was worried because his thinking was slowing down, as were his movements — he felt tired all the time. In addition, he was bothered by a little rash, on which he had tried all sorts of patent ointments.

He did not realize, until it was pointed out to him, that his new prosperity was the cause of all this. The rash, his failing memory, and increasing tiredness, were all indications that he was violating the Rules for Getting a Reserve of Vigor. Since he had been earning a fat salary, he had been indulging in his lifelong suppressed desire to eat all the steak he wanted. Five nights a week he would feast on a double steak, a dill pickle, and a thick slice of pie. He was putting on a little weight, and thought that was a sign of good health. Occasionally he would have one vegetable at lunch, but more often he had none.

He did not dislike vegetables. He merely wanted to eat the more expensive foods which he now could afford. Of course, his diet was seriously off balance. His rash was apparently a dietary dermatitis. The rash, the slowed thinking, the peplessness, and his bowel trouble, all cleared up within a month after he began to practice these rules. He still had his steak, but it was smaller to make room for two vegetables every night. The story has a happy ending, for he is still in big advertising money. In fact, six months after he began to follow these rules he was given an increase—and he had been definitely on the skids only a short time before he was slowing down—the result of eating too well, rather than wisely.

Rule 2: Eat two fruits, or fruit juices daily

These are also necessary for their vitamin and mineral content, in addition to their moderate regulatory action. As with vegetables, the fruits can be either canned or fresh.

The value of the excellent, modern, refrigerated, fresh fruits and canned juices which have been on the market in quantities only since about 1930, cannot be overestimated for their vigor-renewing value, as well as their luxurious time-saving quality. In contrast, we remember grandma as she used to sweat over her stew kettles canning fruits during the ripening season.

Either the fruits, or the juices, can be used as a between-meal snack, as well as at mealtime. It does not matter when they are taken. A good New England custom, for example, is to eat an apple just before going to bed.

That advertising executive who was slipping now indulges his luxury with a large glass of fruit juice each morning, served on a silver tray while he is shaving. I drink my own glass before I leave the house, to climb Blacksmith Hill Road for the mail each morning, and then come home for breakfast. We always have a dish of fresh fruit in the laboratory for a between-meal snack.

It is easy to get two fruits a day—and equally easy to remember the rule.

***Rule 3:* Eat eggs and milk once a day**

These are nourishing foods, as well as protective, but people tend to forget them. They were mainstays in the diet of John D. Rockefeller, Sr., and he did not have a false tooth in his head at the age of 97 years. He would often stop during a round of golf to drink a deep glass of cool milk.

People often ask me if one does not get enough eggs in one's cakes and puddings. The only eggs that count for those who follow this rule are those that do not conceal their identity—an egg that looks up, smiles, and says, "Hello, I am your egg" The only camouflaging the egg can undergo and still count is in an egg-custard. It does not matter how the egg is cooked—it can be deviled, or a pickled egg in the tap room—but it is easiest on the stomach if it has been cooked at the lowest possible temperature, and not very long.

I am also asked if people do not get adequate milk in their puddings This concealed milk does not count with these rules The only way the milk may be disguised is in chocolate milk, milk stew, or as cheese At lunch this noon, for instance, I ate a 12-cent carton full of cottage cheese· A little square of cheese means nothing—it must be a man-sized piece

That advertising genius who started to skid now drinks a bottle of chocolate milk in the middle of each afternoon, in place of the bottle of imported sparkling water he used to affect in his outburst of first prosperity. He also is pleased with the rule's recommendation of cheese, since it gives him an excuse to order the most rare and expensive varieties with his evening apple pie. (He still wants me to count that pie as one fruit!)

Eat anything else you want, but make sure you get the essential three vegetables, two fruits or juices, egg and milk, as a basic diet every day. These need emphasis as they are the things folks tend to overlook—few need to be reminded to eat meats and desserts.

***Rule 4:* Drink enough water to make your urine a light straw color**

Eight glasses of water a day have often been suggested as the ideal quantity, but some people need more water, and others need less. The best index, and one that is easily followed, is to watch the color of the urine; if you are getting the right amount of water, the urine should be a light straw tint

Many people avoid water with their meals, in the false belief that it dilutes the gastric juices and slows down digestion. As a matter of fact, however, experiments show conclusively that digestion is actually helped when water is taken along with the food.

Most of the water people need can be taken during the day, before the evening meal, and then one's sleep need not be disturbed by bladder distention. A glass of water, or fruit juice, is desirable the first thing in the morning.

We have water piped from a protected spring on the hillside to our laboratory. Deliciously cool the year 'round, we take many small drinks of this throughout the day, in addition to having it with meals.

Alcoholic drinks contain a large percentage of water, but water disguised in liquor does not count. The alcohol may make a person forget his fatigue temporarily, but it leaves him in a less vigorous condition after the stimulation wears off. For those who must have their drink, cheap gin, or Scotch whiskey have the least undesirable after-effects, especially if one drinks them in plain water

***Rule 5:* Relax residual tensions before, during, and after meals**

"Business man's stomach" is usually attributed to restaurant cooking. Restaurant cooking may not taste like grandmother's, but it is all right, and should not be blamed. The person himself is usually to blame, for he takes his business and his worries to the table with him. He eats in a tensed condition, instead of the ideal, relaxed condition.

Belching, indigestion, a heavy feeling in the stomach, and bowel disturbances are all caused, at times, by lack of relaxation at mealtime. Some specialists claim this to be the outstanding cause of these vigor-sapping troubles.

I find that folks can remember this rule most easily if they get in the habit of relaxing residual tensions every time they see food or a dining table. Even the sight of someone else eating a candy bar should be a reminder to relax those usually present residual tensions around the jaw, around the eyes and forehead, and on the back of the scalp between the ears.

It is not primarily a question of eating slowly, but of being relaxed in body and mind Relaxing the residual tensions assures a relaxed spirit, and that is the mealtime goal to be sought.

***Rule 6:* Get one hour of sunshine daily**

Five hours of sunshine and a sunburn the first day of vacation do not count It is the regular daily exposure to the Sun's rays that gives real help. As much of the body as possible should get the kindly rays I often walk with my hat in my hand in order to have more area exposed to the sunshine. Many city workers, unfortunately, cannot get an hour of natural sunshine daily, so the farmers outclass them in vigor

It is also difficult to get natural sunshine on much more than the tips of the nose and ears in the winter months, although the entire body would benefit by it. Artificial sunshine lamps can be of service in overcoming this dilemma. If you buy one, make certain that it is approved by the American Medical Association, otherwise you may be buying some wires and switches which appear impressive, but which yield no real benefit. An hour is too long under such a lamp, the book of instructions will tell you how long is safe.

The vigorous, young general manager of a silverware manufacturing company is one of thousands who lets a sunshine lamp help him keep his vigor at a high peak. Each evening before dinner he undresses, takes a 20-minute sun bath, relaxing all the while, and gets up irradiating sunshine himself.

The Sun's rays, as with the three vegetables and two fruits a day, the eggs and milk, plentiful water, and mealtime relaxation, will not produce instantaneous results but 95 out of 100 people will notice definite results in improved vigor sooner or later. How soon depends largely upon the person, upon how starved his body has been for these neglected essentials, and how faithfully he follows the rules every day—including Sundays and Saturday nights. A single breech of the rules may set one back a couple of weeks.

It takes a week or two for the average person to notice clear-cut results from following these rules We can't expect to remedy a lifetime of maltreatment of the sources of vigor overnight, especially if we realize that even a week's maltreatment may require a month for recovery.

***Rule 7:* Have a complete check-up once a year by a physician and dentist**

Automobiles are examined and tuned up periodically, oil changed, batteries checked—all preventive measures to avoid breakdowns, and to avoid any loss of vigor and pep. People, also, should be looked over at regular yearly intervals. Eyes and teeth, as well as the rest of the body, should be thoroughly examined. Those who wait until there are pains, toothache, noticeable eye strain, are locking the garage after the car has been stolen. Minor physical defects which develop from time to time must be caught early, before they have been able to undermine vigor seriously.

People who are pepless and habitually fatigued should have a basal metabolism included in their examination to discover whether, perchance, a sluggish thyroid is responsible for their lack of vigor. If it is, a glandular prescription usually remedies the condition easily, and restores the vigor

Many firms require these complete physical examinations once or twice a year for all key employees The company does not want to take a chance—it costs too much money when an important executive loses his vigor.

One of my closest friends has been very thankful because I insisted that he have a complete examination when his peplessness seemed unexplainable. His physician found nothing, but the dentist discovered some apical abcesses which, when cleared up, seemed almost miraculously to restore him to his old vigor. Another needed eye attention He had felt that he might need glasses for some time, but shunned an examination because he said, "Glasses make men look like sissies." I pointed out that the real sissy was the man who lacked nerve to wear them.

With another it was a sluggish thyroid, detected by the metabolism test. He is one of our foremost public speakers—you would gasp if I mentioned his name. His successful career was at stake, because pep and enthusiasm are indispensable for a public speaker. He could no longer even pretend to be energetic on the platform. Audiences that had formerly listened eagerly for each word began to grow restless. Glandular prescriptions made up for the slight deficiency discovered in his thyroid and he is again the popular, enthusiastic speaker

I am often asked about the usefulness of many common "fatigue remedies" and "pep preparations." Here is a brief summary of current scientific evidence on these:

Yeast, in almost any form, gives renewed vigor. It will seldom be needed, however, by people who follow the rules we have given.

Coffee and tea contain substances which give a temporary boost by lessening the feeling of fatigue for a couple of hours. They do not remove the cause of the fatigue which still remains to sap vigor "Cokes" are essentially the same as sweetened coffee. Their caffein gives the same passing lift, but does not make up for lack of vigor.

Sugar and candies will give heavy muscular workers some needed "quick energy" about a half hour after being eaten People who are in sedentary work may find that these decrease their vigor, however, since they may add more weight, and thus more effort is required to move

BY FOLLOWING the seven simple rules outlined above, the middle aged can regain much of their lost vigor, and the young will go much longer before losing their youthful vim

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YARDSTICK

For Planning the Daily Diet

AMERICANS now have a scientific yardstick for planning the daily diet that will give them health, strength, and morale for total defense. The yardstick, translated from laboratory terms of allowances for vitamins, minerals, protein, fat, and carbohydrate, was announced by Dr. Lydia J. Roberts, head of the department of home economics of the University of Chicago, as follows:

One pint of milk daily for an adult, more for children.

One serving of meat.

One egg daily, or some suitable substitute such as beans.

Two servings of vegetables daily, one of which should be green or yellow.

Two servings of fruit daily, one of which should be a good source of vitamin C, such as the citrus fruits or tomatoes.

Bread, flour, and cereal, most and preferably all of it whole grain or the new, enriched bread, flour, and cereals.

Some butter daily, or margarine with vitamin A added.

Other foods to satisfy the appetite.

Cheaper cuts of meat, Dr Roberts reminded, are just as nourishing as the more expensive ones

NOISE

Ear Plugs Protect Industrial Workers

FATIGUE, irritability, and nervous exhaustion experienced by workers in or about noisy operations are lessened by the use of Ear Defenders, plugs which reduce loud noises by 35 to 45 decibels or to about 1/10 their former loudness, yet are so designed that warning signals and conversation can easily be heard. The resulting effect from the reduction of noise, it is claimed, will enable the workmen to better concentrate on their jobs and thereby increase their efficiency.

Essentially, each Ear Defender, made by the Mine Safety Appliances Company, is a tapered tube molded from surgical-type soft rubber Each consists of two barriers, an outer one of metal and an inner one of soft rubber, separated by an air space. The tapered construction permits easy insertion and removal without any danger of coming in contact with the ear drum. The devices can be easily cleaned with soap and water, thus insuring a sanitary article at all times The cost to the user is thus relatively low in comparison with other ear protectors which must be discarded after being used a short time.

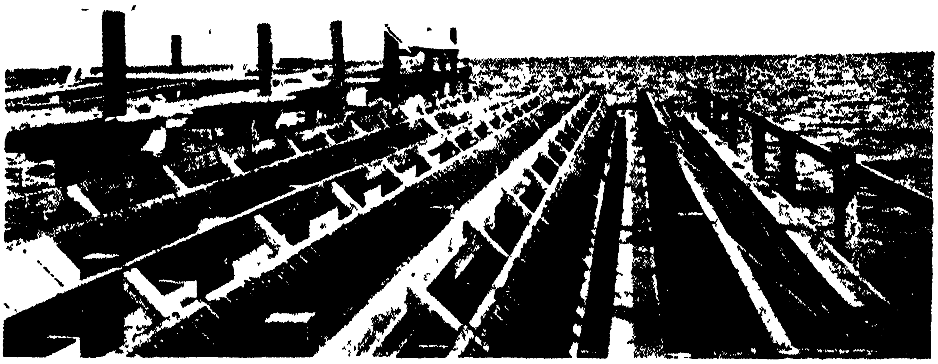
The plugs were designed by Dr. Vern O. Knudsen, an authority on acoustics, and Dr. Carey P. McCord, an industrial health expert

For Better Paint

Methods of Testing Surface Coatings for Metals Have Definite Place in Maintenance

If there's a paradox confronting every maintenance engineer engaged in testing and selecting metal protective paints for general maintenance work, it might be expressed as "making haste slowly." For, although it is true that accelerated tests provide the engineer with much information about a coating that it would otherwise take many years to obtain under actual service conditions, it is equally true that many accelerated tests may produce results that are not typical of exterior exposure or normal service. Hence a balance must be struck, and a combination of tests must be used, as a brake to guard against the ever-present possibility that a really worthwhile coating will be discarded and an inferior coating will be adopted, on the basis of performance in an isolated test of no practical significance. In other words, the aim of all testing work should be to provide a composite picture of a paint's performance rather than one phase of it.

Because in "weather" lies the ultimate answer to the durability of most metal protective paints, every engineer has had to ask himself the question, "What is weather?" The plain and simple answer is that it is variable, unreliable, and constantly changing. Montana's weather means armpit-deep snow in winter and blazing hot sun in summer. Atlanta, Georgia's, weather includes, among other things, a mean yearly precipitation of over 48 inches, and very little of it snow at that.



Tide-water tests of painted panels, such as that shown above, call for careful preparation of the test panels and require expert interpretation of the results

● Protection of metal surfaces by paint coatings to prevent corrosion assumes even greater importance as the need increases for conservation of materials and economical maintenance of structures. Yet, as the accompanying article points out, engineers responsible for this work must exercise care in their interpretation of the tests that have come into wide use, correlating results so as to reach a final decision which will be based on a consideration of all the factors that affect surface coatings.—*The Editor.* ●

For many a maintenance engineer, it is a perfectly logical procedure to forego normal weathering panel testing and apply a test section of metal priming paint to an actual structure. While a single exposure of this type cannot be as indicative as desirable, multiple exposures of the same nature on properly prepared surfaces provide a comprehensive background with which there cannot be any argument.

Sub-Tropical Testing Service

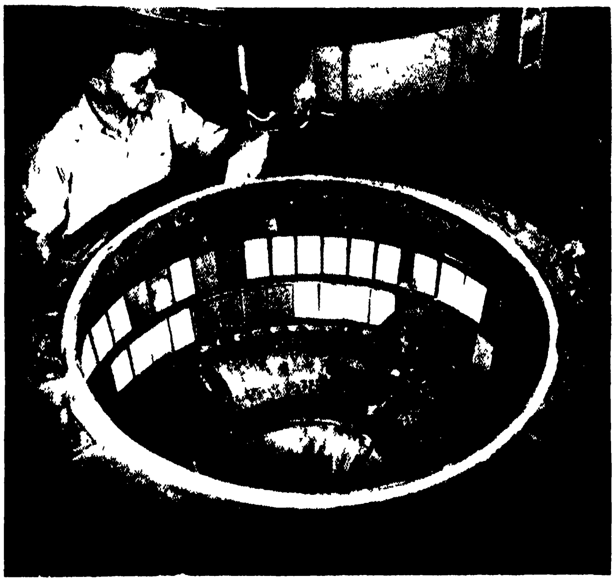
A test panel fence, facing south to insure maximum sun exposure, is of particular use when complete painting systems are to be tested against each other

Next best thing to testing a metal protective paint under actual service conditions is to expose test panels of it to the weather, usually on racks facing south to insure the maximum amount of sunshine. Panels of non-copper-bearing black iron are generally employed. Simple as "normal" weathering exposure may seem, it is not without its pitfalls. For example, many of the best metal priming paints are so formulated that they have characteristics which make them totally unsuitable as finishing paints or for lengthy exposure to the weather. However, when properly protected with suitable finishing coats, they do a splendid job of protecting the metal underneath. Hence, single-coat weather exposures of metal priming paints to the weather, although proceeding with greater rapidity, can sometimes be misleading unless supplemented by test surfaces finished according to the painting system used in ordinary practice. Of course, this same precaution also applies to other test procedures

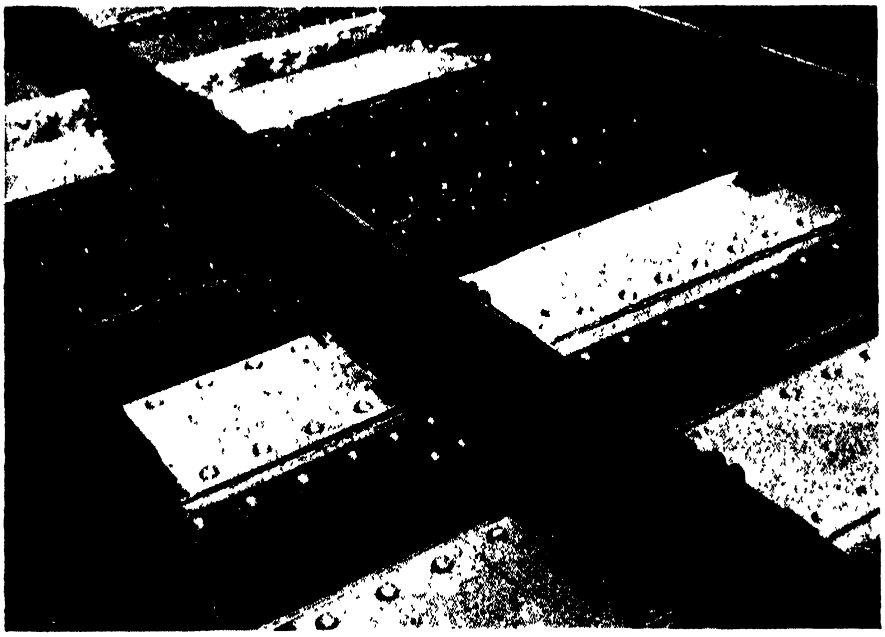
Time was when little attention was given to the nature of the metal panel itself. More recently, studies have shown that the nature and extent of the mill scale on the metal surface have an appreciable effect on the performance of metal priming paints, and that this effect is not the same for all paints It is also claimed—and practical knowledge would seem to support the claim—that the nature of mill scale present on metal test panels is different from that existing on structural steel shapes such as "I" beams, angle irons, and so on. Since the ultimate aim of metal protective paint-testing work is to simulate the conditions which exist on a structure (where some mill scale is nearly always present), it is but a step removed from such conditions to make test exposures of paints on sections of structural steel members The procedure has so far been applied mostly for determining the suitability of metal priming paints as shop coats, but further extensions of its use would seem likely except where the lack of portability and bulk of the tests is a major objection.

Outdoor weathering tests are slow at best, and to speed up results various types of accelerated tests are used Exposures on Florida tidewater test racks provide one type of accelerated test which gives much useful information, especially where the durability of marine coatings is concerned. Because of the severity of the test, which consists of placing test panels on racks so that they are alternately exposed to salt water and Florida sun, failures occur within a relatively short period, usually from 1½ to 2 months. The test provides a more or less fixed set of conditions to which some paint coatings are more susceptible than others and this, coupled with the speed of determination, makes it a valuable supplementary test method However, its highly accelerated nature calls for care in controlling such factors as the preparation of the panel, and warns against drawing broad conclusions from moderate differences in results.

Immersion tests provide clues to service in presence of moisture



In accelerated weathering tests, all factors must be intensified in correct proportion to each other



Many authorities on paint problems prefer small-scale tests under actual service as here, where structural members are given different coatings

Another form of accelerated test which has come into extensive use is the so called laboratory accelerated weathering machine Basically, it makes provision for the exposure of test panels in a predetermined sequence to a mercury arc lamp (to simulate sunlight), humidity as developed by atomizing warm water in the tank, water spray to simulate rain, refrigeration to provide low temperatures, and a combination of sulfur dioxide and carbon dioxide gases similar to that encountered in industrial locations.

The purpose of the machine is not to simulate and strike an average of the weather in any one locality, but to intensify, within reasonable limits, each and every one of such weathering factors, and thus to reproduce in a relatively short period failures which can be interpreted in terms of actual service. Notwithstanding the vagaries of actual weather, "artificial" weathering as obtained with accelerated weathering machines is of real benefit in testing work, provided no one weathering factor (as, for example, light) is intensified to the point where the balance between all factors is lost.

Exposure of metal priming paints, or more particularly metal finishing systems, to chemicals (acids, alkalis, brines, and salt sprays) is never desirable unless these represent actual service conditions. Among tests which are designed to reproduce and measure one particular type of failure, laboratory immersion tests (salt or fresh water) are useful in determining the tendency of metal priming paints to blister under moisture conditions, which are nearly always encountered in actual service.

Difficulty is sometimes experienced in grading the performance of a paint if a number of individuals are making observations of the results The American Society for Testing Materials is now attempting to establish so called pictorial "rusting standards" which, if finally adopted, may become the universal language every paint technologist and engineer can use for designating degrees of corrosion. And that will mark another forward step in the already progressive field of corrosion prevention —Courtesy *Paint Progress* and the New Jersey Zinc Company

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CLOUD CHARGE

Indicator Will Assist in Studying Upper Air

A DEVICE for indicating to airplane pilots the intensity of electricity in a nearby thundercloud, illustrated in laboratory form on page 54, is called a "Cloud Charge Indicator for Airplanes." It is a delicate instrument containing a neon tube and a microammeter and can be mounted on the panel board of the plane. The glow of the neon tube serves as a signal for the pilot.

The instrument is connected to a pointed tungsten rod similar in size and shape to a lead pencil and protruding 14 inches from the plane. The glow of the neon tube rod picks up the electrical discharge from the cloud and sends it through the instrument. This causes the neon tube to flash and the meter needle to deflect. The amount of this deflection indicates the intensity of the electrical disturbance ahead and permits the pilot to change or maintain his course accordingly.

In the laboratory, an artificial cloud-plane arrangement was provided. A brass sphere, about two feet in diameter, was suspended a known distance above a tungsten rod which was connected to the cloud charge indicator. The sphere served as the cloud; the rod, 14 inches high, served as the airplane. Voltages of known magnitudes were passed through the "cloud" and the instrument readings noted. The voltages, or electrical pressures, per linear foot in the atmosphere, were calculated for any given reading on the instruments Data also were prepared for a six-inch rod From these data, charts were prepared for use by the pilot of the plane.

It is hoped that records of the intensities found under various atmospheric conditions and at varying heights from the clouds and at various plane speeds will be kept by the airlines using the instruments. This would provide research engineers with additional data for the study of lightning phenomena

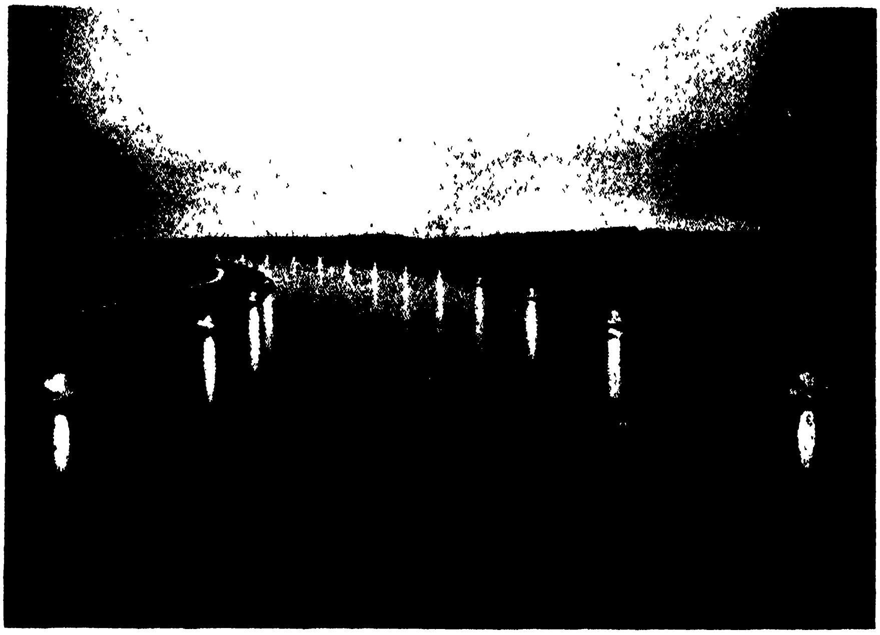
The instrument, consisting of a double-scale microammeter, glow tube, resistors and capacitor, is designed to register up to 400 microamperes

CANAL LIGHTING

Sodium Vapor Units For Cape Cod Waterway

DELAYS caused by fog and other adverse weather conditions have been practically eliminated in the Cape Cod Canal as a result of sodium vapor lighting Saving 65 miles on the New York-Boston sea route, the canal, 7.7 miles long and 500 feet wide, connects Massachusetts Bay at Sagamore with Buzzards Bay at Bourne.

After considering various light sources, sodium vapor lamps were found best able to meet the lighting requirements during foggy or misty weather. For this purpose, the lamps have a distinctive yellow color that is not confused with other artificial lighting. Installed at 500 feet intervals and mounted on pole crook brackets, the luminaires are Westinghouse "Reflectolux, Sr." with bronze globe holders and fittings to withstand salt air The complete installation consists of 146 units with 10,000 lumen sodium lamps. Circuits are sectionalized so that in event of failure in one circuit, half of the lights on each side of the canal will still be operating.



Sodium lights defeat fog dangers

STORED SEED

Germinate Even After Eight Years

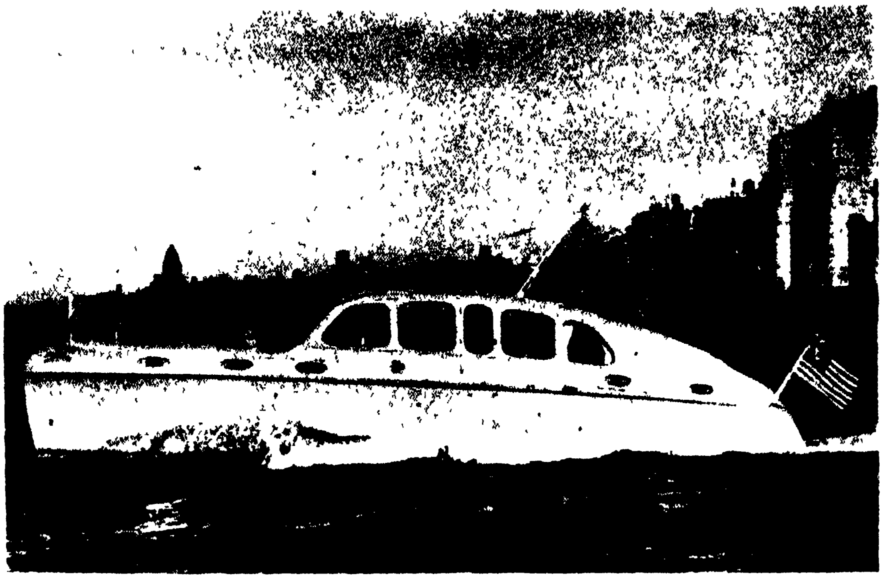
INTEREST in locating good seed stocks for 1942 plantings has focused attention on tests made in the seed-testing laboratory at the State Experiment Station at Geneva, New York, on seed oats and seed barley held in storage for as long as eight years Several stocks of both oats and barley germinated 98, 99, and 100 percent, while other lots showed less than 90 percent germination, according to Dr Willard Crosier

While farmers are not likely to have to use seed stocks as old as these, yet in the spring of 1937 a large group of farmers in central New York found it necessary to use seed oats that had been in storage from two to four years. Evidence that oats and barley seed will retain their vigor and viability over comparatively long periods of time is reassuring in these days when the demand for increased production is so pressing

YACHT

Ultra-Modern All-Metal Cruiser Makes Trial Runs

YACHTING and marine enthusiasts, as well as the Navy and the Coast Guard, are displaying intense interest in a new type of 45-foot yacht cruiser which recently made her maiden voyage of 168 miles at an average speed of 27 miles an hour. Powered by twin 315-horsepower engines, this new boat, the *Revere*, can attain a speed at full throttle of just under 35 miles an hour. This makes her one of the fastest cruising yachts of her size in the country.


The streamlined *Revere*, an all-metal yacht of unique design

Two-way radio equipment aboard the *Revere* is designed to use ten crystal-controlled waves

The interest being shown in this new vessel is accounted for by her unique design. One of the factors contributing to her speed is a completely new conception in hull shape, a conception that could never before satisfactorily be realized in a wooden boat The *Revere* is of all-metal construction—hull, deck, and cabin—and hence her designers could build into her the optimum lines for speed and fuel economy without having to compromise with the limitations of a semi-rigid material. Thus the *Revere* incorporates without change the theoretical lines adapted from models tested at the Stevens Institute test tank.

The hull, deck, and superstructure of the *Revere* are all made of cupro-nickel sheets just a bit over 1/12 of an inch thick. This material, of which Revere Copper and Brass, Inc has made condenser tubes for naval and merchant vessels for many years, is known for its almost perfect resistance to salt-water pitting and corrosion It is this resistance to corrosion that has helped to make possible the use of thin and light plates. In the past, metal boats have been forced to use heavy plates, resulting in high cost and loggy performance In the design of the *Revere*, all of the metal was figured in design and strength calculations, it being unnecessary to make discounts in consideration of corrosion.

In the construction of the *Revere*, pre-shaped sections of the metal were laid according to plan in a previously prepared wooden form They were then joined by welding, resulting in a "one-piece" boat

The *Revere* is completely equipped with radio for both transmission and reception. Ten crystal - controlled transmitting and receiving channels, provided by a standard Hallicrafters marine radiophone, include those for ship-to-ship, Coast Guard, and ship-to-shore communications. This radio equipment offers automatic voice-controlled transmit - receive changeover, instant choice of services by simple selector switches, and operating simplicity approaching that of the ordinary home telephone. This radio equipment has a communication range of several hundred miles, in spite of antenna limitations imposed by the boat's low lines and the midship location of the apparatus

ANCHOR

Plastic Secures Fastenings In Holes

SCREWS, bolts, nails, and hooks can be held permanently in place in wood, concrete, plastics, and so on by the use of a new plastic material known as Sy's Plug. This material is used to fill holes, after which the fastening is driven into place The plug is formed by rolling the plastic material between the fingers into a size that will fit the hole It is then dipped into water and pressed into place Then the screw or other fastening is driven into the plug, which hardens permanently to anchor the fastening in place. The plastic can be also used as a repair material for screw holes from which the threads have been stripped.

TRUE "DRYS"

Animals That Gain All Needed Water Chemically

THAT certain animals have solved the problem of living without drinking water is the contention of Ernest P. Walker, Assistant Director of the National Zoological Park, in the latest annual report of the Smithsonian Institution. Through long periods of evolution, he says, they have developed means of surviving with a minimum of moisture so that today water seems abhorrent to them.

The most specialized of these animals are some of the rodents such as the pocket mice and kangaroo rats of the southwestern United States and the jerboas of Asia and northern Africa. "These animals," Mr. Walker explains, "live in regions where the rainfall is very scant over much of their range, and where water is practically unobtainable. They have, therefore, become adapted to living with almost no water or drink. During the very short time when there is green vegetation they may eat some of it. At other times they obtain no moisture except, perhaps, an occasional drop of dew. But their needs are adequately supplied by chemical processes that take place within their own bodies, where the constituents of dried seeds and other vegetable foods are converted into moisture by oxidation.

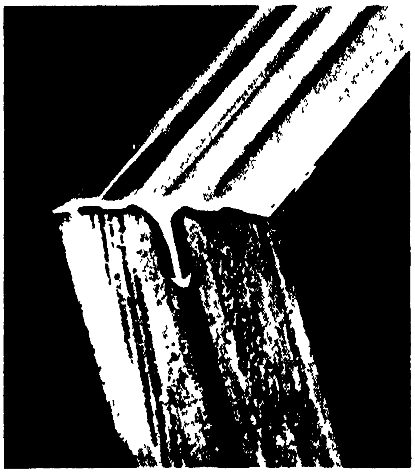
"I have often offered water to pocket mice, kangaroo rats, grasshopper mice, and other desert animals to make certain they did not suffer from lack of moisture. Almost invariably they refuse it, although occasionally they may sip a little and then not touch moisture again for months.

"One pocket mouse seemed greatly offended when I offered her water On a few occasions I dropped a single small drop of water on her and was much amused at her violent antics of rolling in the sand to remove the offending substance from her coat. I am convinced that she never took water during two-and-a-half years Very rarely did she show any interest in eating any moist vegetation. In the case of such a carnivorous rodent as the grasshopper mouse, the blood or body fluids of its victims would supply one of these animals with most of its required moisture."

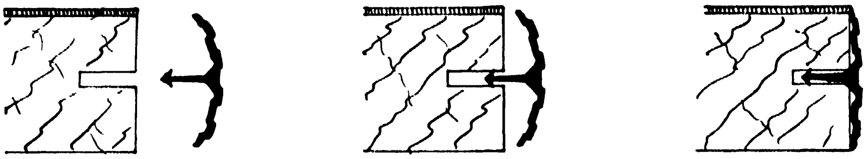
INTERLOCKING

Plastic Strips Replace Metal Trim

Extruded plastic shapes are finding ever widening use in a variety of applications where they replace metals. One of the latest developments in this field is an edging material designed for use on tables, shelf trim, counter edges, and wallboard joints. Illustrated herewith, this new strip form, produced in long lengths, locks into position without the use of adhesive, screws or other means of attachment. Wherever a slot of the proper width can be provided, this "Interlox" section can be quickly and easily applied. When the material is pressed into place, the barbs hold it in position. The material used in the "Interlox" strip is Tenite II, produced by the Tennessee Eastman Corporation. It is available in a wide range of colors and has a horn-like toughness and a high luster. The surface is washable in soap and water, requires no polishing.



Above: Extruded plastic trim in place. _Below:_ How trim is held in position by barbed extension



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GASOLINE: Motor fuel for highway use totaled 22,000,000 gallons in 1940 and for non-highway purposes 2,000,000,000 gallons, according to state reports compiled by the Public Roads Administration.

• • •

SEALING

For Cracks In Water Jackets of Gasoline Engines

Supplied in liquid form, a new sealing material for water jackets and radiators of gasoline engines is claimed to find and seep into cracks and then to congeal into a hard metal-like substance on contact with air. This material, known as Whiz Weld Metal, is claimed to flow readily in the circulation system of the engine and not to clog water passages or circulating pumps.

FROZEN COFFEE

Process Reduces Bulk, Preserves Flavor

Designed to render a joint service to the packer, distributor, retailer, and consumer in the general food line, a new method of processing and packaging foodstuffs is the recent invention of John C. Donnelly. It involves a combination of two methods of preservation—rapid refrigeration and compression.

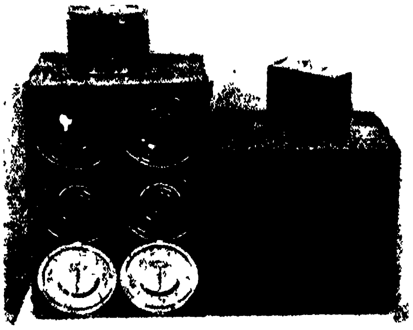
Immediate application of the process for public consumption will be confined to the coffee market. Coffee processed under the Donnelly patent will reach the consumer in cellophane-wrapped compressed and refrigerated blocks, each two inches by two inches by one half inch, packed 20 to the pound. The consequent reduction in cubic displacement will cut distribution and storage costs.

The reduction exceeds 50 percent, according to the inventor, who points out that an ordinary carton used for transporting 12 pounds of vacuum-tinned coffee will accommodate 30 pounds of the refrigerated product.

In its preparation, the coffee is first refrigerated directly from the roasting oven to a point 20 to 30 degrees below zero, Fahrenheit. A state of "suspended animation" is thus created, sealing the volatile oils in the bean itself.

While in this "anesthesia," the coffee is ground and compressed into blocks and maintained in the frozen state until it reaches the consumer. At home, it is again placed in the refrigerator. The volatile oils that account for the taste and aroma of coffee will retain their solidified state and the coffee will remain fresh indefinitely so long as it is kept in the refrigerator.

An added advantage claimed for this process is that the particles of the ground coffee are fractured by the compression in such a manner as to permit a greater aqueous extraction, enabling the user to obtain 15 to 20 more cups to the pound than usual. It is estimated that the average user of coffee in the conventional form throws away 30 percent of yet usable coffee in disposing of the "grounds", Mr Donnelly points out.


12 pounds canned: 20 pounds frozen

Each individual unit of the new processed coffee is a measured quantity, thereby eliminating one haphazard operation by the consumer. Although in compressed form, it is sufficiently friable for convenient home use

TNT

Being Made 70 Percent

From Petroleum

DEFENSE needs for TNT explosives are being supplied for the most part from toluene made by the petroleum industry, in plants now operating or that will be in operation within a few months. The annual production of toluene from the plants now operating and under construction totals 100,000,000 gallons, enough to make 1,000,000,000 pounds of TNT, with 70,000,000 gallons coming from petroleum and only 30,000,000 gallons from coal carbonization, the normal method of making this principal ingredient of TNT. Toluene from coal carbonization is strictly a by-product, and the yield is only 3 pounds per ton of coal. On the average, selected gasoline fractions yield 50 percent of toluene, with a few giving as much as 80 percent in the laboratory.

Two principal methods, extractive and catalytic, are available for the manufacture of toluene from petroleum. Certain crude oils contain enough toluene so that it can be separated commercially merely by an extension of the basic petroleum refining method, straight distillation or extraction. Much greater yields can be obtained, however, by the chemical conversion or synthesis of toluene from certain gasoline fractions of petroleum. The gasoline molecules obtained by distillation and cracking are further processed to cause a chemical alteration, resulting in toluene.

The petroleum fraction used for the catalytic manufacture of toluene is normally a portion of ordinary gasoline. Even doubling the present production so that 200,000,000 gallons of toluene were made from gasoline would have little effect on the supply of motor fuel, he asserted, because this huge amount of toluene, enough to make 2,000,000,000 pounds of TNT, would be less than 1 percent of the annual production of more than 25,000,000,000 gallons of motor fuel

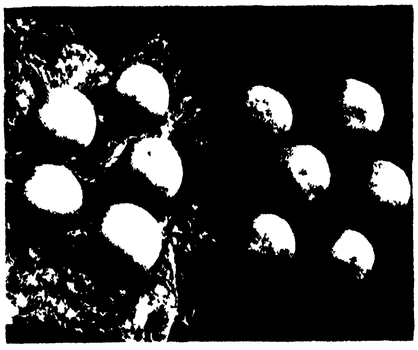
FRUIT WRAP

Moisture-Proof Film

Preserves Fruit

DEVELOPMENT of a new technique in wrapping oranges and other citrus fruits, employing Pliofilm, makes possible the extension of preservation of these important products for months. Tests in the laboratories of the Florida Agricultural experiment station at Gainesville have demonstrated that grapefruit wrapped in this manner and stored at 70 degrees temperature for seven months retained its texture and juices, and seeds showed no indication of sprouting

Pliofilm, the wrapping material used in the experiments, is a moisture-proof, transparent, synthetic plastic developed in laboratories of Goodyear Tire and Rubber Company, and is widely used for packaging food products.


Plump, wrapped: Shriveled, unwrapped

The success of this application is due to the fact that the wrapping allows transmission of carbon dioxide with enough rapidity to keep the fruit from suffocating, but transmits moisture vapor slowly enough to prevent loss of moisture, thus retaining the juices and fullness of the fruit and preserving vitamin content.

Because thin-gage Pliofilm can be used in a special stretch-wrap process which permits a small sheet of the material to be wrapped tightly around a large surface, application of the new development is feasible from an economic standpoint and also enhances the appearance of the fruit by giving it a glossy surface covering

RADIO MEN

Thoroughly Trained

In Four Months

THOUSANDS of young men between the ages of 17 and 28 are becoming trained radio operators through enlistment in the Naval Reserve. Not only are they obtaining training which will likely prove highly valuable on return to civilian life, but in the meantime they are helping the Navy to meet its urgent need for radio personnel, now a doubly important feature as United States participation in the war gets into gear.

Receiving position for training

With the concentrated training program developed by the Navy a man, even without previous radio experience, becomes a qualified operator ready for active service at ship or shore stations after only 16 weeks of training. He is then capable of copying code directly on a typewriter at a rate of 25 words per minute, has developed general familiarity with navy transmitters and receivers, has acquired knowledge of the fundamentals of visual and underwater signaling, and has been trained in basic naval subjects and routine.

Every effort is made to keep this training as practical as possible This is carried even to the extent of providing at the schools groups of complete receiving positions similar to those encountered in active service. These afford practical experience in tuning regular naval communications channels and copying actual naval dispatches from the air. The accompanying illustration shows one of a number of such receiving positions at the U. S. Naval Reserve Training School, Noroton Heights, Connecticut, each equipped with its own Hallicrafters communications receiver.

The Noroton Heights school alone trains 500 operators every four months and others distributed throughout the country are training thousands each year. These are men selected on the basis of aptitude or previous radio experience from among those enrolled at naval training stations.

• • •

EYES: Although parents with brown eyes may have children with blue eyes, very rarely do two blue-eyed parents have a child with brown eyes, according to the Better Vision Institute.

• • •

PAINT CLEANER

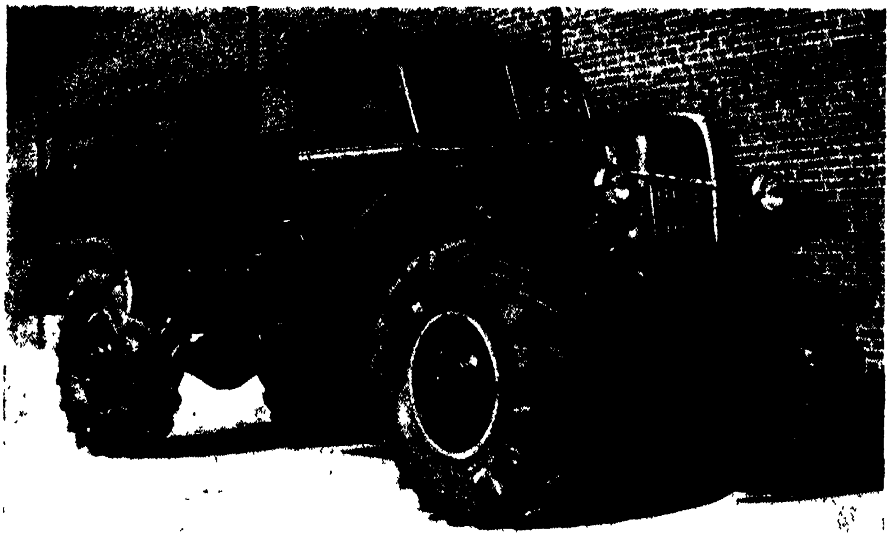
Prepares Old Finished Surface For New Coat

When it becomes necessary to repaint a glossy or enamel coated surface, some means must be provided for deadening the gloss so that the new paint will bond to the surface. With a new material called Imperial Wil-Bond, this job is simplified. Wil-Bond is a clear liquid which is applied with a cloth to remove dust, grease, and wax. It also cuts the gloss from the surface and sets up a slight tack which insures a complete bond with the new paint If the surface to be refinished is clean and free from grease, the Wil-Bond liquid need merely be added to the new paint before application.

ALL-WHEEL-DRIVE

Replaces Ox-carts in Geological Service

From ox-cart to a modern all-wheel-drive truck is a pretty long jump, but nothing in between could do the job, according to Gordon Barbour, president of the Barvia Company of La Paz, Bolivia.



Marsh buggy for geological operations in Bolivia

Mr. Barbour owns gold and oil properties far back in the interior of Bolivia where the only roads are ox-cart trails over mountain, marsh, and plain. As many as 20 oxen are employed in places to pull a single cart at speeds of 15 to 18 miles per day

As a result of experience with a previous purchase of a Marmon-Herrington light delivery all-wheel-drive converted Ford, Mr. Barbour was convinced that a similar vehicle with much larger tires and other special features would be exactly what he needed to conduct geological surveys over his properties

The vehicle finally developed presents a rather weird appearance, but from tests made locally, there is no question but that it will render the service expected Starting with a standard ton and a half truck, engineers proceeded with the same conversion to all-wheel-drive which has been done with thousands of similar units for industry and military services. But the change did not stop there. In addition to equipping the truck with a heavy duty winch and air compressor, both operated from a power take-off on. the auxiliary transmission, two complete sets of tires were provided. The first set, for operation on paved roads, were 9.00 by 20's all around; while the others were mammoth 13.50 by 24's, dual mounted on the rear wheels, to provide the extreme flotation and traction necessary for the worst imaginable cross-country operation.

• • •

CAR AGE: 43 percent of all the motor vehicles ever sold in United States are still in operation. 74 million cars have been sold up to the end of 1940, and 32 million are still in use.

• • •

BEETLE CONTROL

Possibilities of "Milky Disease" Bacteria

Injecting a tiny helping of "milky disease" bacteria into the body cavity of a Japanese beetle larvae is a ticklish operation. If a fleshy little larva wiggles — and wiggle they will — the intestine may be punctured and the injected inoculum lost.

So United States Department of Agriculture entomologists have discovered a way to take the wiggle out of the larvae during this delicate operation — by anesthetizing them S. R. Dutky of the Bureau of Entomology and Plant Quarantine has found that larvae may be anesthetized for a period of eight hours with little or no ill effect. He uses dry ice to furnish the carbon dioxide anesthetic.

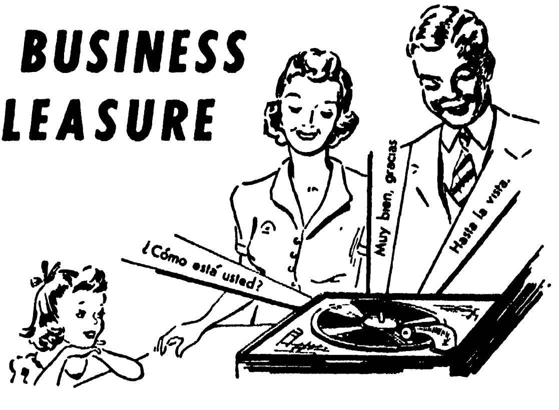
"Milky disease," natural enemy of the Japanese beetle, is being tested widely by entomologists as a beetle-control measure in heavily infested areas. The bacteria are injected into healthy Jap beetle grubs, where they multiply. Bodies of grubs so injected are ground, mixed with talc, and dusted over the ground or placed in soil where grubs are feeding. A feeding grub takes up the disease germs which reproduce in tremendous numbers until there are enough to kill the grub. Grubs killed by the disease

(*Please turn to page* 88)

LEARN THE EASIEST OF ALL LANGUAGES

Speak SPANISH AT ONCE

FOR BUSINESS OR PLEASURE



Expanding U. S. trade with South America means *new opportunities* if you can speak SPANISH! Today, more than ever before, American firms need SPANISH-SPEAKING export managers, clerks, translators, salesmen, engineers, stenographers, secretaries, business and professional people.

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Remember, SPANISH means greater social advantages, too. Everyone should know at least one foreign language. With SPANISH, you discover new and interesting cultural fields. And imagine the thrill of being able to stray away from the "beaten paths" of the conducted travel tours—and truly *enjoy* out of the way corners of lands to the south!

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Our Search for the Supernatural

Do Mediums Fear to Face a Scientific Investigation of Psychic Phenomena?

A. D. RATHBONE, IV

Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

IT SEEMS fully apparent at this time that most mediums, psychics, and spiritists have no desire to attempt to prove once and for all that there exists a basic, truthful, scientific explanation of their so-called phenomena. Presumably, if the lack of collaboration which our Committee has thus far received in its investigation of psychic matters is any criterion, most producers of psychic demonstrations prefer to continue their activities in their own dimly-lit or darkened mediumistic parlors with their own groups of "believers" without benefit of public acceptance that the things that take place there are factual, and not hoaxes Indeed, one leader in the psychic world, himself not a medium, has emphatically urged that all persons who claim supernatural power avoid our Committee and its earnest efforts to prove the truth, as though the idea of psychic research were a pestilence.

True, we have had demonstrations, we have had seances, but of none of them can it be said that anything of a startling or outstanding psychic nature presented itself. While we are beholden to those mediums who have come forward in an effort to co-operate for the benefit of the public by conclusively proving the existence, the presence, or the motivation of psychic forces, we must, nevertheless, conclude that the mediumistic world as a whole is fearful of the clear, cold light of a scientific investigation. It has been estimated that upwards of 50 million dollars yearly is paid to mediums, psychics, seers, fortune tellers, and others who claim occult powers by persons who seek answers to the query of what lies ahead, or to establish alleged "contact" with those who have passed on. This is big business, even in these days of fabulous figures, and it may be that there is reason for the lack of co-operation to date.

When, last April, Scientific American joined forces with the Universal Council for Psychic Research in an effort to determine the truth concerning psychic matters, it was emphatically stated "that this proposed inquiry into psychic and spiritistic phenomena in *no* sense questions any form of religious belief, but is solely a scientific study to determine the true facts concerning what have been termed 'supernatural manifestations'" In other words, this investigation is not a "witch hunt", it does not seek to belabor, besmirch, or to expose any person or his belief. Rather, it is a conscientious attempt to settle an important question, one which, because of war and unsettled social and economic conditions, has become greatly amplified in the public mind. In times like these, far too many people turn to secret rites of cults or individuals in a desperate venture to satiate their craving for knowledge of the future; they are, unconsciously, perhaps, trying to allay a gnawing fear. This, we have maintained, is an attitude inimical to the national welfare; it is a dangerous trend—*unless* the claims of the psychics and the mediums are true!

IF IT is possible to contact forces of which we now know nothing, and if those forces can be of assistance to individuals and to the nation in this time of peril, then, by all means, let us know more of them—let us make use of them in this national emergency. If mediums and psychics are, for some thus far unknown reason, persons peculiarly adapted to perform this service to the country, then let us enlist their services at once. *But,* before that action can be taken, they must prove beyond all question of a doubt that the ability they profess to possess to contact the "spirit world" is authentic, that their theories are tenable and truly applicable to the best interests of the public at large

If the psychic forces do exist, if they can be contacted by specially gifted persons known as mediums who claim that certain physical psychic manifestations are proof of such contact, then beyond a doubt the fears and the worries of thousands of us can be alleviated by further knowledge of the occult. However, just as a man who joins our armed forces must demonstrate his physical and mental capabilities for such service, so must the spiritists, psychics, and other purveyors of mediumistic service prove their fitness to be publicly considered as an authentic source of knowledge of what transpires in another world or of what will transpire in this one In this respect it is again and again emphasized that these statements do not refer to Spiritualism as a religion, nor to any other form of religious belief, the tenets of which may provide mental and spiritual solace, especially in times of severe trial. We are concerned only with those who, for compensation or otherwise, allege that they can produce psychical manifestations of a physical nature which are in turn interpreted as demonstrations of occult forces, or which are construed so as to give "messages," information, or to prognosticate the future

THE Scientific American Committee for the Investigation of Psychic Phenomena is a body originally constituted and consistently maintained to endeavor to ferret out the truth regarding spiritistic phenomena To that end, six simple regulations were laid down to govern the activities of the Committee and any persons or organizations who might be willing to co-operate with the Committee, and an award of $15,000 was established through the joint appropriations of Scientific American and the Universal Council for Psychic Research. (April 1941) In regard to the award, criticism has arisen that this is an objectionable feature, but it must not be forgotten that the announcement that a substantial sum is available for the unequivocal proof of what is today unproved is, in itself, evidence to all and sundry of good faith. Further, mediums or others who may join in our search for the supernatural might be put to expense or actual loss by working with us, and deserve remuneration, if and when the psychic premise can be followed with *quod erat demonstrandum.* Again, if

Supernatural!

The World of Mysterious Phenomena

WHAT are the strange journeys of the soul? Who speaks the words you hear within? Are the visions you glimpse, and which lift you to the heights, pranks of the mind or are they momentary glimpses into a world of phenomena of which man is yet in ignorance? Is there an intelligence which manifests in an extraordinary manner or can all unusual experiences be explained by natural law and order?

The word SUPERNATURAL rings throughout the world today as it has for centuries But in this age an impartial investigation and a serious study of the unusual can be had What greater fascination is there than that of the unknown? What greater enjoyment can be had than an inquiry into the mysterious? The greatest minds of all ages have put themselves to this task of investigation Some oppose and contradict each other, but their findings constitute a wealth of knowledge.

This Free Book of Daring Truth

Behind every strange — eerie or weird — happening which we experience, lies a fundamental law of nature The difference between fear and self-confidence is the understanding of these laws *Once you know the cause*, the most unusual events or occurrences of your life, or of the world in which you live, are no longer mysterious. Have you wondered about the causes of hunches, and what accounts for the peculiar impressions or premonitions you have?

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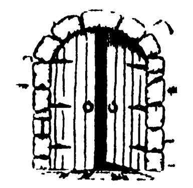
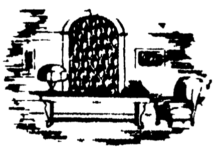


The supernatural is the open door to a *natural* world of mystery.



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any psychic feels that his or her services would be tainted by acceptance of the award, its donors will gladly make it payable to any charity or other beneficiary, duly and legally appointed.

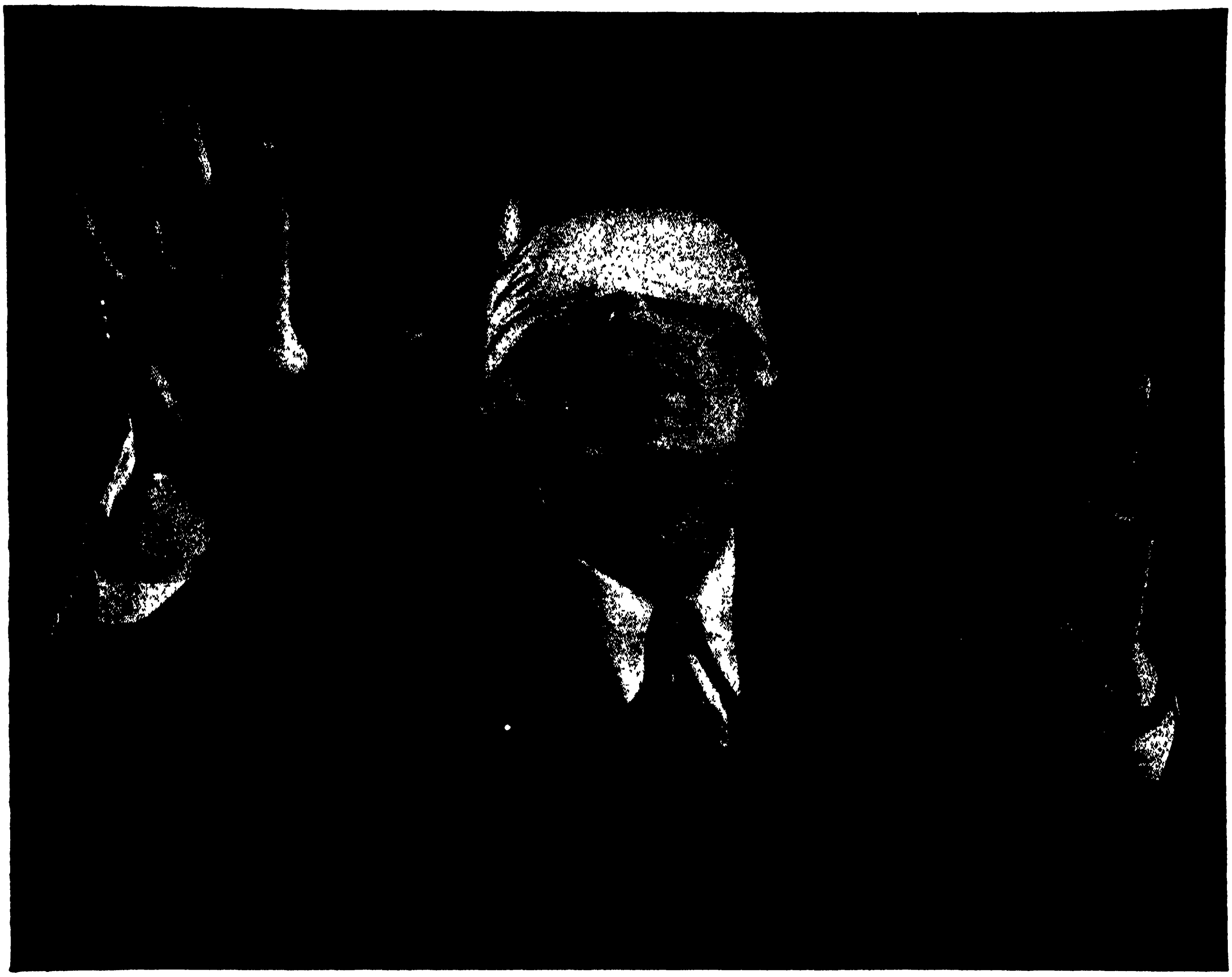
As for the regulations, they are, as has been pointed out, simple in the extreme. We ask only that formal application in writing be presented to the Committee stating that any phenomena produced by the medium will be "accomplished solely by supernatural, spiritistic, or psychic agencies, and not through trickery, abnormal physical development, legerdemain, or mechanical devices." Certainly, if the medium sincerely believes he or she has psychic powers and has no need to resort to trickery—as many have been shown to do—there can be no objection to this requirement.

Naturally, demonstrations or attempted demonstrations must be performed in the presence of our Committee or such of its members as may be appointed by the Chairman, and, as a corollary, the Committee or its Chairman may request repetition of seances or demonstrations. Most important of all, perhaps, is the regulation that "demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration, so long as such conditions are compatible with the best interests of the aims of the Scientific American Committee." Obviously, the Committee, en toto or in part, cannot today journey to the Philippines, Mexico, or Brazil, as has been suggested by certain correspondents. Nor is it feasible under present conditions to hold Committee meetings here, there, and everywhere, but any medium or psychic who desires to appear before our Committee in New York City or its immediate environs will be welcomed.

IT IS extremely noteworthy that there are *no* test conditions placed on the medium at the first appearance before the Committee. He or she is entitled to demonstrate unmolested and unhampered, despite the fact that in some instances in the past, the mediumistic operations proved immediately to be transparent as fraud to one or more members of the Committee. Furthermore, even if test conditions are imposed at a later seance or demonstration, the Committee agrees "to the best of its ability to see that its conditions do not hinder or inconvenience the medium or demonstrator." As Scientific American is the official publication of the Committee, its publishers reserve the right to present the findings to the public. Finally, it must be remembered that the present investigation does not incorporate telepathy, telepathic experiments, or any other form of mental phenomenon or demonstration.

IN THE past, through the efforts of Scientific American and other investigatory bodies, it has been conclusively proved that certain individuals who termed themselves "mediums" and who claimed to have contact with psychic forces had no such contact and had utilized mechanical appliances or other "human" means to produce their so-called phenomena. These people had accepted money from the public for their "demonstrations." This, however, is not to say that psychic forces do not exist or that they may not be contacted. Somewhere there may be a person or persons who have succeeded in one of man's ever-hopeful ventures—to determine survival after death, to communicate with the spirits of the next world, either or both accomplished with physical rather than mental evidence as proof. If such there be, let him now come forward and work in harmony and in full confidence with the Scientific American Committee for the Investigation of Psychic Phenomena. All that is sought is the truth, the scientific explanation concerning this age-old problem, but unless broader and more generous co-operation can be obtained in the future from the disciples of psychic belief, their silence and failure to co-operate can only be construed as too significant to need further comment.

There can be no doubt that the controversy of today over this question is essentially the controversy of 1000 B.C. translated into modern terms and given an up-to-date setting It is, perhaps, too much to hope that it may ever be permanently settled, but it does not seem too much to wish for that our Committee may be instrumental in producing conclusions for this generation, conclusions that will be effective at least until this generation grows old and dies off, in favor of another generation with a shorter memory. To that minimum of effect our Committee will continue to bend its efforts.



WHITE COLLAR MEN ARE STILL A DIME A DOZEN!

LOOK around your office. A few men have "arrived". They are the executives, earning big money. The others are what the top men in the company call "white-collar workers"—able, conscientious, hard-working—perhaps with specialized training, but they are nevertheless figuratively worth a dime a dozen.

WHAT'S THE DIFFERENCE between the executive and these "white-collar workers"? That's the question being asked by men who have hopes . . . men who want to climb out of the rut and into the top-flight class themselves. The answer is—*there's very little difference!*

Has the man who makes $5,000 twice as much brains as the man who makes only $2,500? Has the man who makes $10,000 twice as much brains as the man who makes $5,000? Of course not! And it would be amazingly easy for *many men* to transform an average salary into a large salary!

HOW IT'S DONE! The difference between success and merely "getting along" lies in executive training. In the old days, successful executives had to gain their ability through long years of experience. But as business became more complicated, educators became business-minded. Many big universities added schools of business; the Alexander Hamilton Institute was founded—and since then has pointed the way to success to more than 400,000 men!

HOW YOU CAN DO IT. The Institute has organized and formulated the knowledge of the country's most successful business men. Co-operating with it are dozens of leaders like Edward R. Stettinius, Alfred P. Sloan and Thomas J. Watson. As a result, the Alexander Hamilton Institute offers you modern, up-to-the-minute training and information you would almost have to give your right arm to gain by any other method!

CUSTOM-MADE TO SUIT YOUR NEEDS. Please get this fact clear in your mind. *The Alexander Hamilton Institute offers a PERSONAL service, geared not only to YOUR particular needs, but to your particular needs TODAY—whether you are a young man just earning his first business laurels, or a busy corporation official who wants to keep up with rapidly changing economic conditions.*

PUT IT UP TO US. Why not prove to yourself that you have the first quality of an executive—the ability to make a decision? Write us for a free copy of that important little book, "Forging Ahead in Business". For many men this simple act has been a major turning-point in life!

I'M TIRED OF STANDING STILL! HERE'S WHERE I START MOVING!

Alexander Hamilton Institute, Inc.
231 Astor Place, New York, N. Y.

Please mail me, without cost, a copy of "Forging Ahead in Business".

Name . . . .
Business Address . . . .
Position . . . .

(*Continued from page* 82)

turn milky white, disintegrate, leaving little heaps of disease germs to be picked up by the next generation of grubs — and so on.

MOBILE POWER

Railway-Car Plants

For U. S. Navy

THE Bureau of Yards and Docks, Navy Department, has ordered two 10,000-kilowatt mobile steam-electric power plants mounted on special railway cars from the General Electric Company to supply emergency power wherever its projects may require.

The mobile power plants will be the first of their kind to be built, but the turbine generators, boilers, and electrical equipment used in them will be apparatus of the types proved in service in regular industrial installations.

Each of the units will be housed in two specially built railway cars which can be hauled over the rails at speeds up to 40 miles per hour.

The power-generating car will contain a 10,000-kilowatt turbine-generator and its accessories, a condenser, and the necessary switchgear. The boiler and its auxiliaries, along with a starting engine generating set will be housed in the second car. A mobile substation, constructed on a standard car, will be used in conjunction with each generating unit to permit proper voltage to be obtained for any Naval Shore Establishment.

Engineers estimate that the mobile power plants can be put "on the line" within 24 hours after they are shunted into a siding.

Bunker C fuel oil will be used to fire the boilers, and each unit will consume about three tank cars a day when operating at full load. A sufficient fuel supply for two hours' operation will be carried in the boiler cars of each of the units, however, so that they can generate power before the tank cars are hauled up and connected.

COACH-SLEEPER

Features New Economy

In Rail Travel

COMFORT and economy for the railroad traveler are the two factors which influenced the design of a new coach-sleeper recently put into experimental use on several railroads by the Pullman Company.

Triple-deck berths

The cars are completely new in design, being provided with a side aisle and a series of compartments. For daytime use these compartments are made up with seats for three passengers in the single units or for six passengers—in groups of three, facing—in the double compartments

For night use, the compartments are converted into sleeping quarters for three in the single sections and for six in the double sections. Access to the center and upper berths is provided by a sturdy stairway-type ladder which is removed in the daytime set-up of the compartment. Each one of the berths is provided with a reading light and an individual control for air from the general air conditioning system of the car. In each compartment is a wash basin furnishing hot and cold water, a dental faucet, a mirror, and an electric shaving outfit. In addition to these facilities there are two individual wash rooms and a toilet located in each end of the car.

These new cars accommodate 42 passengers in ten single compartments and two double compartments.

TIME

To Exact Second With

New Wrist Watch

THERE are many spheres of activity, particularly broadcasting, where time to the exact second is necessary. As a matter of fact, there is no timepiece of a portable kind that can keep time to the exact second for any very long period. Furthermore, in a conventional watch, when the stem is pulled out to set the minute and second hands, the action merely disengages them from the movement. The movement continues to run, and the second hand continues to turn. It has not been found practical because of high gear ratio to disengage the second hand from the movement. In a new watch just announced by Longines, however, pulling out the stem not only frees the hour and minute hand, but also stops the watch.

In remote broadcasting, where

Double compartment in new coach sleeper, set-up for daytime use

AIR-RAID DEFENSE

Calls for Specialized Knowledge Based on Practical Experience

WITH virtually the entire civilized world in the throes of war, and air-raids a common topic of discussion everywhere, it becomes of paramount importance for everyone to inform himself on the subject. And the best source of information is England, where the populace has been subjected to over 500 raids from the sky. Experience gained by that valiant nation has been incorporated in a number of books, covering the various aspects of the situation, and these books are now available in the United States. The most outstanding of these have been selected, and short descriptions of them appear below.

CIVIL DEFENSE

By C. W. Glover

INTO over 900 pages of text, photographic reproductions, and drawings the author has packed a vast amount of information on the whole subject of protection of civilians and their property from air raiders. Factual information is given about various types of bombs, how they function, and how best to combat their effects. The discussion of bombs covers high explosives, incendiary, and gas. Then follow exhaustive chapters on building construction in general, strengthening of existing buildings, air raid shelters of many types, air-raid precautions, organization of civilian defense units, and a vast amount of pertinent information. The illustrations greatly enhance the practical value of the text. $16.60 postpaid

THE HOME GUARD TRAINING MANUAL

Edited by John Langdon-Davies

HERE are presented the basic facts that should be known when planning the organization of a civilian defense unit, whether the object be for combatting sporadic air raids or stemming actual invasion of military forces. The text, accompanied by a few drawings, covers such phases of the work as observation and communication, obstruction and demolition, rifles of various types, hand grenades, anti-tank and anti-aircraft warfare, discipline and drill $2.60 postpaid

PLANNED AIR-RAID PRECAUTION

By Techton

PREPARED by a well known British firm of architects, the text of this volume deals particularly with large-scale air-raid shelters designed to protect the population of whole cities from the dangers of air attack. The proposals made are based upon careful study of the problems involved and upon the application of engineering knowledge to the needs of the situation. A number of drawings illustrate the thorough going text $2.60 postpaid

AIR-RAID DEFENSE

By Curt Wachtel

THE subject matter of this volume covers more than its title indicates. It not only delves into the construction of air-raid shelters from all angles, but also considers such matters as the political and military concepts of totalitarian warfare, starvation, sabotage, mental and moral destruction, economic aspects, hygienic standards in fact practically all of the problems that must be faced intelligently by the population $3.60 postpaid

AIR-RAID PRECAUTIONS

TEN separate parts make up this volume, all of them essential to a clear view of the whole subject. These parts cover: Rescue parties and clearance of debris; Organization of decontamination services; Organization of air-raid wardens' service; Structural defense, Communications and reporting of air-raid damage; Notes on training and exercises; Gas detection and identification; Protection of windows; Inspection and repair of respirators and oilskin clothing; Care and custody of equipment $3.10 postpaid

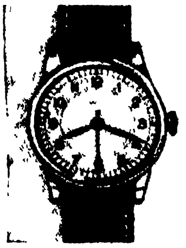
These books constitute a complete library of information of vital importance to every citizen of the United States.

For sale by

Scientific American

24 West 40th Street **New York, N. Y.**

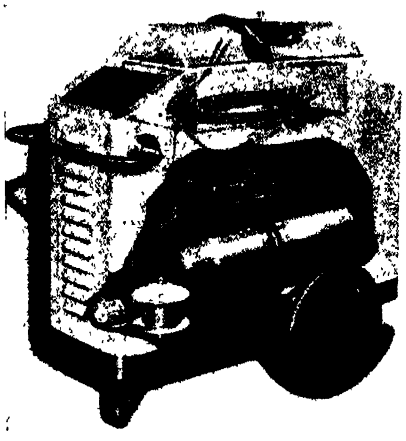
programs must be dove-tailed into a schedule controlled by the master station control clock, there is time lost and uncertainty on the part of the man running the remote show because he never knows to the second when he should be ready to go. This new Longines watch can be synchronized with the station control clock before the engineer goes on a remote job, in this way; when the second hand of the watch reaches the "12" position, the stem is pulled out, and the watch stops. The minute and hour hand are then set a minute or so ahead of the time shown on the control clock. When the control clock reaches the time set on the watch, the stem of the watch is pushed in, and the watch starts, synchronized to the precise second with the master clock. The watch is of conventional strap watch size, and under ordinary conditions will remain synchronized with the master clock for several hours, and operations can be carried out exactly as if the station clock was being consulted. Since the watch can be stopped, reset, and started as often as desired, it can also be used as an emergency timing watch.


Wrist watch that can be set to exact second

CHARGER

Portable Unit For Vehicular Batteries

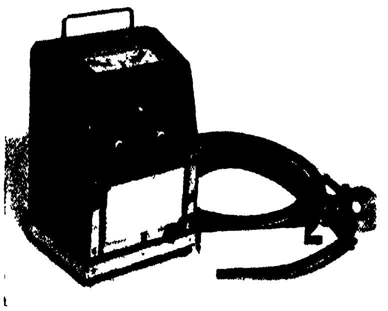
STORAGE batteries for motor vehicles can be charged without the necessity of removing the battery by using a new gasoline-driven portable battery-charging unit recently announced by W. D. Foreman. The gasoline engine of the unit is of the air-cooled type and is directly connected to a generator. The latter is provided with the necessary controls and a pair of cables that terminate in battery clips. The complete unit is assembled on a two-wheel truck. A fuel tank, air cleaner, and other essential accessories make it completely self-contained.


Auto battery charger

FUEL ECONOMY

Stepped Up By Mixture Indicator

IN VIEW of the present gasoline situation, all motorists and operators of trucks and busses will be interested in an instrument that makes possible a sharp reduction in fuel consumption by enabling them to secure maximum mileage per gallon of gasoline. This instrument is identical in operating principle to that of the Cambridge Aero-Mixture Indicator which enables pilots of thousands of Canadian, British, and American military planes and air transports to attain maximum cruising range through greater economy in engine performance.


Maximum mileage indicator

Gasoline ignites only when mixed with air and it is the function of the carburetor of an automotive engine to mix these elements in the proper proportions for combustion A mixture of 15 pounds of air with one pound of gasoline insures complete combustion. This ideal air-fuel ratio of 15 to 1 is not desired in general practice, even though economical in gasoline consumption, because the gasoline engine does not develop maximum power with such lean mixtures. Maximum power is obtained in the usual automotive engine with an air-fuel ratio of from 13.0 to 13.5 to 1.

Since no great loss of power results when the mixture is over-rich, the tendency is to set carburetors on the rich side—and the owner pays for the gas wasted. It is possible by analysis of the exhaust gas of a motor to accurately determine the composition of the mixture supplied by the carburetor. By the use of the Exhaust Gas Tester as a guide the position of the pointer on the scale of the Tester will show at all times whether or not the proper carburetor setting has been made. This small and compact portable instrument analyzes the exhaust gas while the engine of the vehicle is working either in the garage or on the road. Hookup merely requires one to insert the sampling tube of the tester into the tail pipe of the vehicle and the instrument shows instantly the air-fuel ratio and the corresponding percent completeness of combustion

• • •

RUBBER—Production of combat airplanes alone requires more than 50 different articles made from natural and synthetic rubbers.

• • •

ROD-LIGHT

Flashlight Combination For Emergency Use

A COMBINATION torchlight-flashlight made with a 5¾-inch rod of "Lucite," methyl methacrylate resin, aids police officers directing traffic and avoiding dangerous tie-ups, and provides a warning signal for motorists and truckers stalled at night in any kind of weather.

One use for the new rod-light

The "Lucite" rod is completely lacquered a brilliant red to give off a bright, penetrating glow, except at the end, which is crystal clear, emitting a strong ray of light similar to that of a flashlight. The light may be attached to a fender with a suction cap. The plastic rod is reported to have high light transmission, to weigh little, and, furthermore, to be virtually unbreakable.

CHINA STRUCK

Oil Well Drillers Find Pay Dirt

TEXAS oil-well drillers, who've been keeping a weather eye out for China, can relax now. It's been sighted. Researchers, doing a little prospecting on their own, have found it, spelled with a small "c," in abundant supplies of pay dirt, hitherto unknown in Texas—volcanic ash.

From this unique formation, there has been developed china tough enough for Army mess boards and fine enough to grace the governor's banquet table. The new porcelain, three times stronger than ordinary china and of an unequaled snow-whiteness, will tend to relieve the shortage of fine china imports from European countries, it is believed

PAINT REMOVER

Requires No Washing Of Surface

PAINT, enamel, lacquer, varnish, and shellac can be readily removed from surfaces that must be refinished, by the application of a new paint remover which requires no washing of the surface after use. The remover, known as No-Wash, is a liquid which remains wet after it is applied to the surface to be stripped. No-Wash and the surface coating are then removed with a scraper. No residue is left on the clean surface and hence no further work has to be done before the application of new paint. It is claimed that No-Wash does not raise the grain of the wood or injure veneer.

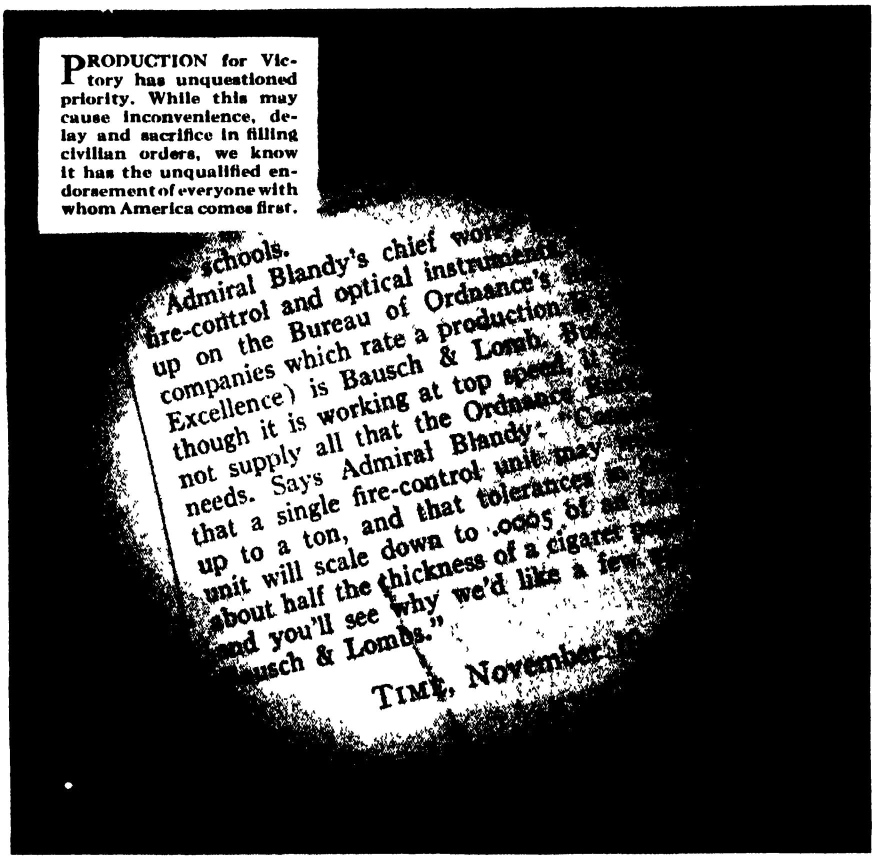
HOME REPAIRS

Pulverized Patching Material Of Many Uses

AMONG the most trying of household problems is the repair of leaks in roofs, cellars, around chimneys and windows, and many other places Recently there has appeared on the market a material known as U-Mix-It which is claimed to give the answer to many of these problems. This material has been developed from a formula utilizing pulverized asphalt which has a melting point of over 250 degrees, Fahrenheit; by the use of various solvents it can be converted by the home user into a paint or a variety of putty-like substances.

Mixed with kerosene, gasoline, turpentine, or other solvent it forms a paint which can be brushed or sprayed, or, by combining the pulverized asphalt with sand, cement, asbestos, or other fillers, a weather proofing and sealing compound can be obtained which may be applied with an ordinary putty knife or trowel. It is claimed that the mixed product has extraordinary adhesion for most of the materials to which it will be applied. Besides the repair problems mentioned above, the mixture can be used for preserving wood, for tree surgery, for lining fish pools, and for sealing cracks in tanks, dams, silos and so on. In all uses the material is said to be completely water-proof

PRODUCTION for Victory has unquestioned priority. While this may cause inconvenience, delay and sacrifice in filling civilian orders, we know it has the unqualified endorsement of everyone with whom America comes first.



schools.
Admiral Blandy's chief wo
fire-control and optical instrum
up on the Bureau of Ordnance's
companies which rate a production
Excellence) is Bausch & Lomb. Bu
though it is working at top speed, it
not supply all that the Ordnance
needs. Says Admiral Blandy: "C
that a single fire-control unit may
up to a ton, and that tolerances
unit will scale down to .0005 of an
about half the thickness of a cigare
and you'll see why we'd like a few
Bausch & Lombs."
TIME, November

Why Bausch & Lomb?

THE ability of Bausch & Lomb to produce the highly specialized optical instruments needed by the armed forces of the United States was not born of the present emergency It has been acquired over eighty nine years of research and unbroken experience

Today the abilities and facilities and accumulated experience of Bausch & Lomb are being directed in their entirety to filling the needs of Production for Victory. Needed immediately are the instruments of which Admiral Blandy speaks—the rangefinders, binoculars, aerial height finders, and photographic lenses

Vital as these are, there are others equally essential which Admiral Blandy did not mention Among these are the spectrographic and metallographic equipments used in the analysis and quality control of cartridge cases and armor plate, the contour projectors and the tool-makers microscopes for the fine measurments upon which mass production of tanks and airplanes depends. To help maintain health and efficiency, military and civilian, there are microscopes, diagnostic instruments and spectacles.

BAUSCH & LOMB
OPTICAL CO • ROCHESTER, NEW YORK
ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR NATIONAL DEFENSE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

GLUE SPREADER

Industrial Unit Holds Two Quarts

For spreading glue on large work surfaces, a new tool known as Glue Gun holds two quarts of liquid adhesive. The liquid is fed to a head which spreads it to a width of one inch on the work. The head includes a corrugated roll and a doctor bar to insure uniform coverage.

For spreading liquid adhesives

HAND GUARDS

For Protection of Industrial Workers

A practical finger guard, or finger stall, combining tough leather and flexible lastex, has recently been designed by the Industrial Gloves Company. This new safeguard is comfortable and durable, gives protection on fingers and thumb, in any combination, to buffers, polishers, sanders, grinders, operators of stamping-out presses, assemblers of small parts, book binders, trimmers, mechanics, and machine operators, both women and men. May be worn *under* glove for extra protection. If worn with leather on back of finger, Steel-Grip finger guard protects knuckles from raps, cuts, abrasions.

Another development by the same company is the new "fingerless" glove which meets the unusual requirements of operators who must have complete freedom of the fingers—"touch" to sort or pick up thin sheets or small parts. Complete protection, however, is provided for the palm of the hand and between thumb and fore finger. In addition to being made of chrome tanned leathers, the glove is steel stitched which eliminates the possibility of ripping The glove may be worn over the bare hand or over light-weight glove

HYDRAULIC VISE

Pedal Controlled, Capable Of Heavy Work

Pressures up to five tons between jaws, and the possibility of considerable savings in time and labor, are offered by a new hydraulic vice which has been developed by the Studebaker Machine Company.

The new vise is designed to speed up small press and cutting operations, as well as ordinary vise work, and is understood to have wide application on production lines, in tool rooms, and for maintenance work. It is operated entirely by foot control, permitting the use of both hands in setting up and removing work. The unit is self-powering.

Pressure to close the jaws is controlled by a foot-pedal pump arrangement in a pedestal mounted on the floor. The latter is connected with the vise proper by a steel tube which carries the hydraulic fluid to a ram behind the back jaw and thus moves it forward; the front jaw is stationary.

Stepping on one pedal moves the vise jaw to contact against the work while a second pedal applies pressure up to five tons and a third pedal releases the jaw

Some of the different types of jobs the new hydraulic vise can perform are presswork, punching, bending, cutting, straightening, testing, and stamping. Because the operator can use both hands, exceptionally heavy work can be easily handled with a degree of precision heretofore impossible. Also, due to the pressure exerted, certain special work can be handled, impractical for the ordinary vise.

INSULATION

For Wires Makes for Smaller Motors

The efficiency of nylon as an insulator permits the manufacture of motors requiring 10 to 15 percent less space than those of equivalent capacity using conventional magnet wire insulation, with a corresponding saving in vital core metals like iron, it is reported by the Du Pont Company.

Motors such as those made for small power tools, fans, vacuum sweepers, refrigerators, pumps, ignition coils, generators, food mixers, voltage regulators, and other household and industrial appliances may incorporate enamel-like nylon insulation

Nylon coating, it is said, provides insulation resistant to abrasion and cracking, has good dielectric strength, and is not adversely affected by any of the conditions of moisture, temperature, compression, or chemical action which such motors normally encounter

SOLDERING

Tool With Hinged Tip, Dual Heat Range

A copper tip which can be positioned at various angles to the handle is one of the features of a new electric soldering tool made by McKinley-Mockenhaupt Company. This construction also makes it possible to provide access to the heat element merely by removing a knurled cap without

Soldering — at an angle

having to take the tool apart. The point of hinging between the head and handle is so located that the tool remains in comfortable balance regardless of the angle of adjustment.

With this new soldering tool, it is also possible to increase the amount of heat concentration at the tip By pressing a button in the handle and holding it down, input to the heating element is increased for quick temperature recovery or to assist in maintaining the required temperature on a given job. These tools are available in two sizes. The smaller size is rated at 100 watts at normal heat and 400 watts at fast heat, the larger size consumes 150 and 600 watts.

SPRAY CONTROL

Photo-Electric Cell Speeds Shell Production

Automatic spray machines with photo-electric cell control are now being produced by the Eclipse Air Brush Company for use in coating the inside and outside of projectile shells in one operation. The shells are placed manually on a turntable and then automatically carried to a position in front of automatic spray guns that coat the outside, while an extension nozzle on another gun comes up to spray the inside. The action of the guns is controlled by the photo-electric cell so that there is no spray unless a shell is in position It is claimed that this machine will handle 75mm armor-piercing shells at a rate of 500 an hour.

DRILLS

For Hardened Steel, Chilled Castings

A drill which will cut hardened steel of any type, temper, or analysis is the latest development of the Black Drill Company. Known as the "hardsteel" drill, this tool has been used successfully on carburized, oil hardened, water hardened, cyanided, and nitrided pieces of high carbon, high chrome, and high-speed steels of every degree of hardness.

Hardsteel drills are made by a secret process. They are designed to drill, ream, countersink, and counterbore, and they will do so without tearing or annealing the steel on which they are used, leav-

IMMEDIATE DELIVERY
LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS

		Inlet	Outlet	Price	With A. C motor
No 1	Centrifugal	¼"	½"	$ 6 50	$25.00
No 4	"	¾"	½"	13 50	32.00
No 9	"	1¼"	1 "	16 50	35.00

← GEAR

No 1½	Gear	⅛"	Price $ 9 00	With A C. motor $25.00
No 2	"	¼"	" 10.00	" " " 27.50
No 3	"	⅜"	" 11 50	" " " 28 50
No 4	"	½"	" 12 50	" " " 32 00
No 7	"	¾"	" 15 00	" " " 37.50
No 9	"	1 "	" 16 50	" " " 49 50
No 11	"	1¼"	" 48 50	" " " on request

HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H P. motor, air tank (300 lbs test –150 lbs A W P), automatic adjustable pressure switch, gauge check valve, safety valve and drainer, etc Delivers 150 lbs pressure Displacement 1 7 cu ft per min

Model S H T ¼
12" x 24" tank A C 110 or 220 v 60 cycle **$57.50**
16" x 30" tank A C 110 or 220 v 60 cycle **$64.50**

Large stock of air compressors, ¼ H P to 20 H P A C and D C, all voltages, 1 to 120 C F M displacement, built for all requirements Additional data on request.

Exhaust Fans, Bucket Blade, G. E. A.C. 110 volt motors.

	RPM	cu ft per min	Price
9"	1550	550	$12.00
10"	1500	550	13.50
12"	1750	800	18.00
16"	1750	1800	19 50
16"	1140	1650	27.50
18"	1750	2500	22.50
18"	1140	2100	32.00
20"	1140	2800	36 00
24"	1140	4000	42 00
24"	850	3800	45 00

Other voltages & frequencies available at slightly higher prices

ROTARY PUMPS FOR VACUUM AND AIR

Especially designed for laboratories jewelers dentists doctors hospitals etc Also for small gas furnaces
No 1, max pressure 5 lb **$8.90**
Complete with AC 110 volt motor **$25.00**
No 2 max pressure 10 lb **$13.85**
Complete with AC 110 volt motor **$30.00**

General Electric Immersion Heaters

Suitable for heating liquids, tanks, kettles, etc (1 KW raises temperature 100°F 3 gallons per hour) Fitted for 1½" iron pipe thread. Can be used as 110, 220 volt or 3 heat 110 volt

600 Watt **$7.50**
750 " **7.50**
1200 Watt **$10.50**
2000 " **12.50**
3000 Watt . **$15.00**

We have on hand a large variety strip (space) heaters Quotations on request

Synchronous Motors

New Emerson 100th H P, 900 R P M 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount, no base Has many applications $7.50

"BUSH" CONDENSERS TINNED COPPER

Designed for refrigeration and air conditioning Has many other uses High heat transfer capacity and great efficiency

Sizes 7¾ x 12½ **$3.25** each
" 9¾ x 11¾ **3.50** "
Limited number of larger sizes on hand.

MOTOR DRIVEN PUMP

Brown & Sharpe pumps, new, can be used for gasoline, oil, kerosene, and other fluids Standard ¼" input and output pipe thread ¼ in shaft Size 4x3¾x 3½ diam
Sh. Wt 8½ lb $5.00
Complete with motor 20.50

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ing a smooth, burnished surface within the hole.

They have been used as salvage tools, for drilling holes in dies, tools, and pieces of machinery which have been hardened and cannot successfully be annealed for machining; but their most important uses occur in production. Though hardsteel drills are a new invention, they have already eliminated many expensive grinding and machining operations, and are coming into more general use as production tools.

They have been adapted to a number of unusual uses. They will ream chilled castings without noticeable wear, they will cut manganese steel with ease in spite of its work-hardening qualities, they will drill fired porcelain without chipping or breaking it, they will cut sheets of pure carbon, and they will penetrate baked enamel without cracking it.

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A TINY brush, no bigger than a finger, designed particularly for the aircraft industry but applicable to many other industries, has been developed by the Osborn Manufacturing Company. The little tool, used to clean a small area around rivet holes, bolt holes, and so on, speeds up such work and makes it possible for one man to do the work previously requiring several.

It cleans around holes

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When it is realized that there are approximately 1,000,000 rivets and numerous bolted connections in a $50,000 military plane, many of which require a metal-to-metal bond, it isn't surprising that entire crews of men, using older methods, were required to work 24 hours a day preparing surfaces.

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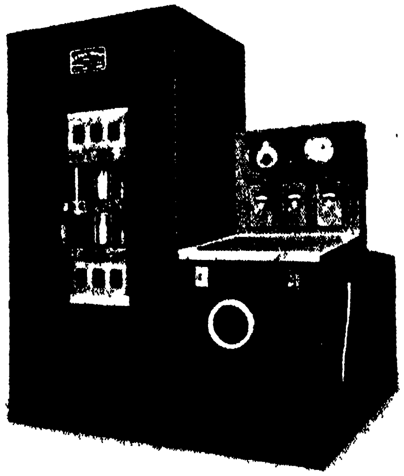

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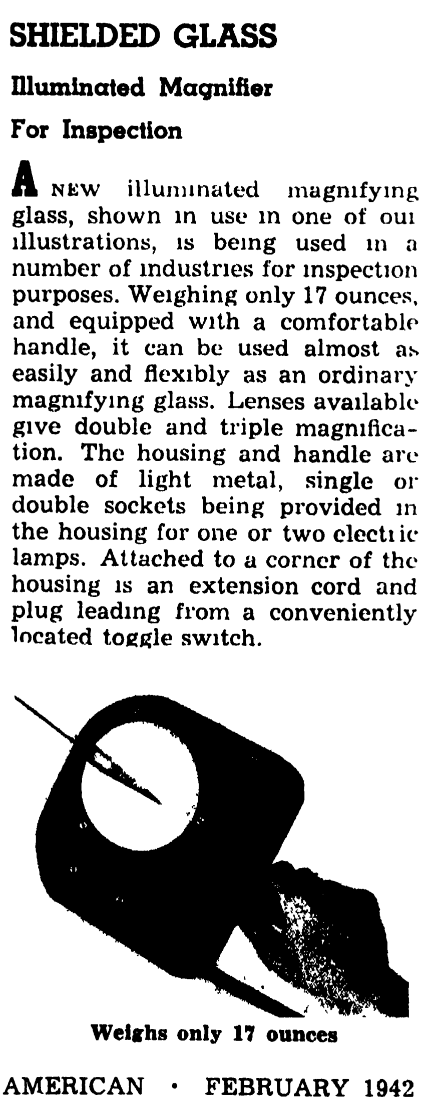

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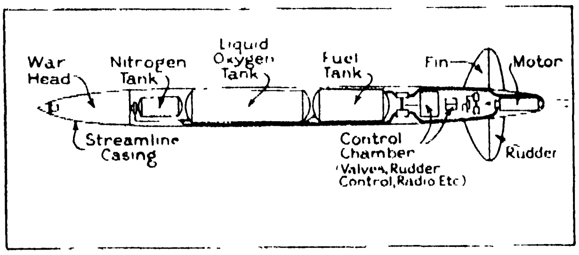
Military Rockets

Anti-Aircraft Traps, Rocket Shells, Weather Study, Airplane Starters, are Possibilities

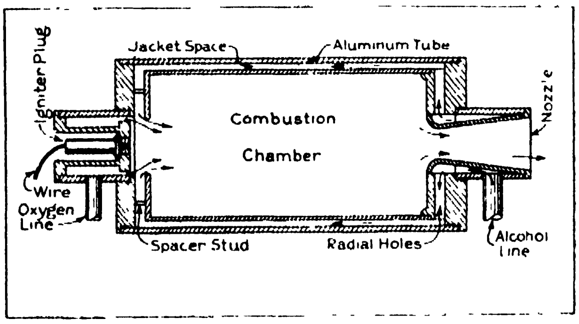
ALEXANDER KLEMIN
Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim School of Aeronautics, New York University

WRITING in the *Military Engineer*, H. Franklin Pierce, President of the American Rocket Society, suggests several war uses of rockets. It is possible to criticize some of the suggestions and some of the methods recommended, but it must be admitted that the article is valuable and thoughtful In the struggle with aggressor nations, every possible type of weapon should be canvassed.

What would a simple rocket for military use look like? Rocket and motor are schematically illustrated in the diagrams, reproduced by courtesy of the *Military Engineer* The rocket derives its power from the combustion of alcohol or gasoline in combination with liquid oxygen. The two propellants are carried in separate tanks of simple construction. A third tank carries compressed nitrogen, admitted to the fuel tanks through a suitable regulator, and producing pressure which forces the fuel into the rocket motor through a system of valves and feed lines, at a pressure of about 300 pounds per square inch.



Layout of a military liquid-fuel rocket of the type discussed in the text



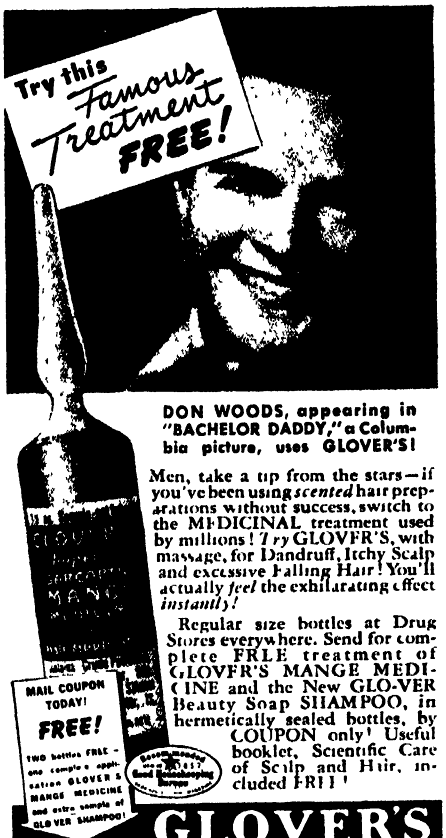
Schematic section of a rocket motor, showing combustion chamber, nozzle, ignition arrangement, and so on

The rocket motor, shown in the second diagram, is merely a combustion chamber provided with a nozzle for the escape of the exhaust gases whose reaction provides the driving force of the motor without the intervention of propeller or other device Fins at the rear give stability during flight A control chamber could be equipped for radio reception and wireless control of the rudder and hence of the direction of travel. Nothing very formidable in all this, though a rocket is not cheap as compared with a shell.

Now as to the various possible military uses of rockets·

Today's three-inch anti-aircraft shells are not very effective and do not reach the required altitude. The German bombers were able to reach London again and again in spite of a tremendous concentration of anti-aircraft guns, which were slowly brought into position beforehand and whose fire was tremendously expensive. Rockets, "fired" from a light launching rack would be more mobile, they could reach great altitudes, and they could carry aloft trapping devices such as a wire mesh provided with parachutes. A rocket barrage with parachute-supported wires would be a formidable obstacle.

A rocket starts from the ground with zero velocity and accelerates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as long as its fuel lasts. After the fuel is used up it behaves like a shell. Thus a rocket could readily be designed to reach 30,000 or even 40,000 feet. Perhaps there is here a formidable weapon against enemy bombers? The author recalls that the rocket played a part in destroying Napoleon's invasion fleet against England. Perhaps large rocket shells could become a species of long distance artillery?

Another application of the rocket which has received much attention is its use in weather prediction. A rocket of the liquid fuel type could carry a radiometeorograph, rise to altitude more rapidly than a sounding balloon, and would return for refueling with the aid of a parachute. Another advantage of a rocket over a sounding balloon would lie in more ready recovery of the apparatus.

Finally, the rocket, inefficient as it is for propulsion at the present speeds of the airplane, could be used to give an enormous thrust to planes at take-off and thus permit our long distance bombers to be greatly overloaded.

There are many difficulties, and space will not permit their lengthy discussion. Yet it must be admitted that these are not idle visions but serious, well thought out, plausible suggestions which deserve to be carefully considered by our military authorities.

FLYING BOAT

Could Fly Non-Stop to Europe and Return

IN 1910, Glenn L. Martin flew a rickety looking single float seaplane in the first extended overwater flight from the California mainland to Catalina Island and back. More than 30 years later, Ken Ebel, Glenn Martin's chief engineer tested the world's largest flying boat.

Mr. Ebel is one of those rare persons who combine the talents of a designing engineer with the skill of the best and most scientific pilot. His ability to gage the results of his own design work is of inestimable value to the aviation world.

The new ship, the XPB2M-1, is powered with four Wright Cyclone engines of 2000 horsepower each, and can fly non-stop to Europe and back and drop a sizable load of bombs somewhere on the way. It has a span of 170 feet, an interior as large as a 16-room house, and carries a crew of 11 men with assignments to such duties as navigation, piloting, radio, and gunnery. Its weight is 140,000 pounds which is second only to that of the latest Douglas bomber, the B-19.

The great patrol bomber behaved beautifully on its first flights. The photograph indicates the clean lines of the hull. Marked chine lines have disappeared in the effort to reduce air drag and the straight sides of the hull blend nicely into the high wing. No tip floats are visible; presumably they have been retracted into the wing. —*A. K*

Despite the recent trial-flight accident to the XPB2M-1, this ship, also known as the "Mars," bids fair to take its place among the world's finest. The fact that the ship, with one engine aflame, was quickly brought under control and safely landed; the further fact that members of the crew were able to crawl into the damaged wing and extinguish the fire, indicate superior design.—Ed

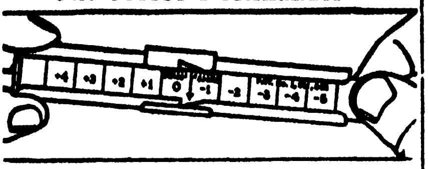
SKYFARER

Only Two Controls, Plus Tricycle Nose Gear

A RECENT and interesting addition to the ranks of light planes is the Skyfarer. By skilful utilization of aerodynamic principles, the Skyfarer achieves a large degree of immunity to the stall and the spin. In fact, it is placarded as incapable

The Martin XPB2M-1 — 8000 horsepower

The Morse Decimalizer



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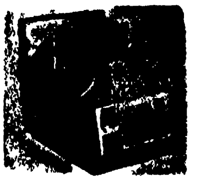

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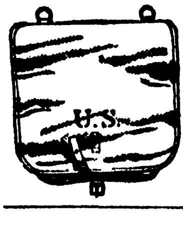

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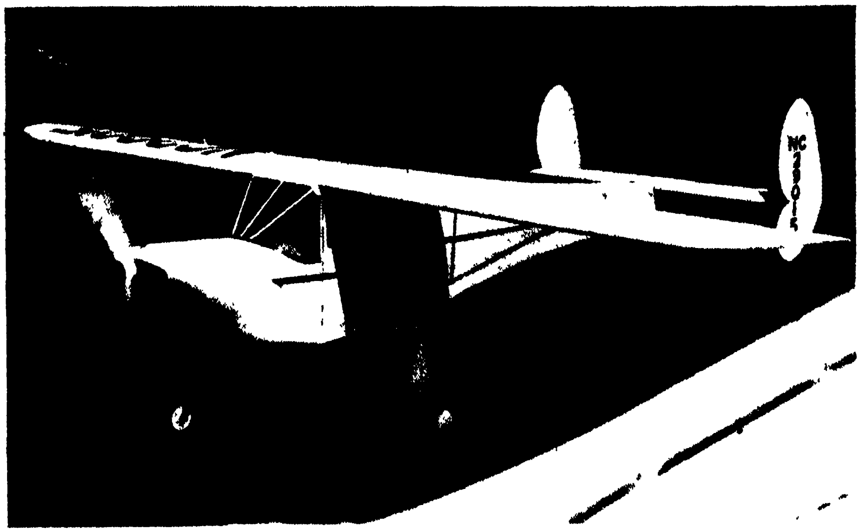

An interesting light plane, the Skyfarer

of spinning, but that is too much to hope for under every conceivable circumstance. Let us say, rather, that the risk of a spin is very much reduced.

In small planes, flaps are not as a rule incorporated, yet the Skyfarer has them, and the designers were perfectly right in using for a light plane an accessory which has proved itself so useful in larger machines. The rudder is eliminated, so that there is one less flying control, and the student has only to use a wheel, back and forth for elevator control, turning for steering just as in an automobile.

The ability to operate on two controls, thus making it easier to learn to fly, is achieved in somewhat the following manner· The plane is banked with the ailerons in the usual manner, whereupon it side-slips towards the lower side The wind strikes the over-size tail surfaces from one side, and the plane automatically goes into a turn. Of course, the two-control system, which has been known for many years, has disadvantages to balance its simplification. A plane using this system has not quite the maneuverability of the three-control airplane. Also, there are times when the pilot would not only like a rudder, but would also like a powerful emergency rudder if he could get one.

The General Aircraft Corporation is to be congratulated on adding still another valuable feature to the Skyfarer, as a rule found only on larger machines—namely, the tricycle nose gear. With the tricycle nose wheel, landing in a side wind loses much of its terror. The machine may land side-wise, but the front wheel immediately castors into the direction of motion, so that the plane is soon running quite normally along the ground. All tendency to "ground loop" is thus avoided.

The Skyfarer is very roomy, and exceptionally well equipped for a low-power plane. There again we are fully in accord. The low-power plane should be just as comfortable, just as well equipped as is the low priced automobile, with brakes, hydraulic shock-absorbing struts, a full line of instruments, and so on.

With two occupants, a 75 horsepower Lycoming engine and enough gas for a long trip, the top speed is 100 miles per hour. With flaps down, the landing speed is only 45 miles an hour. There is provision for 40 pounds of baggage and 20 gallons of gasoline—*A K*

LIGHT PLANES

Can be Useful in National Defense

When the war ends, we shall see an enormous increase in private flying, with many of the Army and Navy pilots clamoring for small planes to continue what will become their avocation. But is there any reason why we should be pessimistic regarding the small plane even under the present conditions? Not at all. The private plane owners can render real service in completing our national defenses, by reconnaissance, by ability to fly quickly anywhere to render aid, and in a dozen ways supplementing our more official defense system. And the light planes have shown real possibilities in Army maneuvers in Tennessee. Taylorcraft, Piper and Aeronca companies donated light

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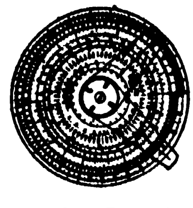

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planes for these maneuvers, and their performance convinced the War Department fully of their utility. The requirements and achievements of these light planes, from an Army point of view, is that they shall be capable of short-range liaison flights, approach the hovering speed of the autogiro, and have ability to land in and take off from extremely small spaces. Flaps and slots are utilized to the fullest. The machines are generally two-seaters with a 65 horsepower, four-cylinder engine as the power plant —*A. K.*

RESCUE LAUNCHES

Patrol the Sea for Fallen Airmen

The R.A.F. has a small navy of its own in the form of rescue launches, constantly cruising the sea, even in the worst weather, and ever on the alert for airmen who have dropped into the ocean These 53-foot long launches are propelled by three Napier aero-engines of 500 horsepower each and have a top speed of 40 miles per hour, a cruising speed of 32 miles per hour. At maximum speed they have an endurance of 12 hours (sufficient to cover about 500 miles), but their cruising range is considerably greater.

Because these launches are frequently attacked by German aircraft, they carry defensive machine guns, and rescue crews have often drifted helplessly for hours in heavy seas after their engines had been damaged by German fire. Sometimes this miniature navy operates in waves 30 feet high, when they can only see a few yards ahead. Aircraft help them to spot drifting airmen and a criss-cross pattern system is used for final location. These fast craft carry first-aid outfits, life belts, restoratives, and have to navigate very carefully at times to avoid mine fields.—*A. K*

ASSEMBLY LINE

Speeds Up Production of Airplane Parts

Once upon a time the aircraft mechanic was a romantic person who, with three or four others, built a rickety craft which carried the leader of the small crew aloft on perilous and fame-capturing flights. Now the Glenn L. Martin Company has installed the belt-conveyor line shown in one of our photographs Of course, time is saved, less skilled men find employment, and the weapons against aggression come faster. But gone will be much of the romance

Here is how the new method of making certain sub-assemblies operates. "Two or more assemblymen at the head of the belt pace the line Before them are jigs in which the pre-formed or pie-shaped pieces are fitted together and the first drilling operations performed, vari-colored patterns telling instantly the size of the drill to be used The pieces are then laid on a belt and the drillpressman picks them up, drills the various holes. Farther along the riveting machine operators fit certain pieces together and rivet them Another man burrs the rivets. Still farther along other workers fit parts of the sub-assembly together, and finish the job. — *A. K.*

Airplane parts on an assembly line

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Kodacolor Prints

COLOR snapshots even with a box camera, the long-awaited boon for the amateur with modest equipment, are here at last through the medium of Kodacolor roll film, a new color product just announced by the Eastman Kodak Company. Made public by Dr. C. E. K. Mees, the company's Director of Research and Development, the new process is hailed as "the greatest achievement in photography since George Eastman pioneered and introduced the first black-and-white roll film in 1889."

Kodacolor is a complete new process and is not to be confused either with the recently announced Kodak Minicolor prints from 35mm and Bantam size Kodachromes, or with the now obsolete process called Kodacolor which was introduced some years ago by Kodak for an entirely different additive process of color photography used for amateur color movies.

Designed especially for the millions of Marys, Janes, and Johns in this country who have been waiting ever since photography was a pup to see their prints in color rather than black-and-white, Kodacolor is available in six standard camera sizes, exposures numbered 1 to 6, with supplementary numbers for "split-frame" cameras These sizes include 120 (2¼ by 3¼ inches); 620 (2¼ by 3¼ inches); 116 (2½ by 4¼ inches); 616 (2½ by 4¼ inches); 122 (3¼ by 5½ inches), and 127 (1⅝ by 2½ inches). Price per negative varies with size from 20 to 40 cents each Prints are 40 cents each in any size

Literally, picture-making with Kodacolor roll film amounts to snapshots in color because, just as with ordinary black-and-white film, the amateur exposes his film as usual in any ordinary camera and receives in return, as with black and white, negatives and prints The only difference, aside from that of price, is that the prints are in full natural color instead of black-and-white As with black-and-white negatives, inspection of the color negatives will show light areas of the subject as dark and vice-versa In addition, the negative will contain colors, not the true colors that will appear in the final print, but colors complementary to those in the actual subject. A red sweater, for example, will be blue-green in the color negative.

Kodacolor has a rather fast emulsion speed, about Weston 20, which makes it adequate for use with box cameras in good sunlight as well as for relatively rapid action at large stops when using faster lenses. The basic exposure in good sunlight for average subjects, Eastman reports, is *f*/8 to *f*/11 at 1/50 of a second.

As with Kodachrome and Minicolor prints, exposed rolls of Kodacolor film must be sent to the Eastman plant in Rochester, through dealers and photofinishers, for processing and printing. Negatives to be printed are either selected by the customer after being returned or the choice of negatives suitable for printing is left to the judgment of the company

The size of the final print is fixed at 2⅞ inches wide. Since the negatives are smaller than this, in most instances, this will mean a slight enlargement, except in the case of the 3¼-inch width of the 122 size, which will be slightly reduced to conform. The length in all cases will, of course, be proportionate to the enlarged width

In explaining Kodacolor, Eastman gives the following technical data

"Processes of color photography involve invariably the preparation of three pictures, each taken by one of the primary colors—red, green and blue-violet—and then their recombination to form the final color picture In the Kodachrome process, the three pictures are taken one over the other on three layers of emulsion The film is coated four times The bottom layer is sensitive to red light and registers the red picture; the layer above is sensitive to green light, the top layer is sensitive to blue light, and a yellow filter is placed between the top layer and the two lower layers, so as to protect them from the blue light

"After the film is exposed, the images of the three layers are developed, and then these images are converted into positives produced in dye by what is known as the 'coupler' process of development. The dyes are put in one after another by three successive treatments with developing solutions containing the proper couplers, so that when the film is finished, the bottom layer, in which the picture was taken by red light, contains an image formed in blue-green dye, the middle layer contains an image form in magenta dye, this being the color which is complementary to green; and the top layer contains an image in yellow dye, yellow being complementary to blue. In this way, a color picture is obtained.

"Some years ago, the Kodak Research Laboratories conceived the idea of working out another process in which the couplers are contained in the emulsion layers, not dissolved in the gelatin layer itself, but dissolved in very small particles of organic materials which protect them from the gelatin and, at the same

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time, protect the silver bromide from any interaction with the couplers. In this manner, the couplers are held out of contact with the silver bromide until the film is immersed in the developer. Then the oxidized developer penetrates the particles and there reacts with the coupler and forms the dye inside the particles suspended in the emulsion. This process has now been perfected and introduced to the public under the name of Kodacolor.

"The new Kodacolor process, however, differs very markedly from Kodachrome although it is essentially of the same character. The film is coated with the three light-sensitive layers as well as a yellow filter layer In each of the emulsion layers are suspended microscopically small particles of organic compounds insoluble in water, and these particles contain the couplers required to produce the dye appropriate to each layer when they react with the oxidized developer. After exposure, the film is processed with a developer of which the oxidation product will react simultaneously with all three couplers and thus produce a dye image along with the silver image in each layer. After the silver has been removed, a negative is obtained composed of dyes in which the image is not only negative as regards light and shade but in which all the colors are complementary to those of the original subject "

Dog Photographer

AN OLD cotton blanket for a background, simple lighting, and a 35mm camera to make many exposures in quick succession, if necessary, is all the equipment Arthur S. Mawhinney, F.R.P.S., uses to make the dog portraits which have now made him famous. A selection of 70 of his portraits of famous dog champions of the larger breeds was recently hung in the American Museum of Natural History in New York, under the auspices of the Oval Table Society of New York.

Stingo of Shotten of Greenfair

A characteristic Mawhinney dog portrait is reproduced, the result of patient assistance on the part of Mrs. Mawhinney, who has the sometimes difficult task of posing the dogs. We are told that it sometimes takes as much as an hour or longer to get the attitude and expression the Mawhinneys want.

Mr. and Mrs. Mawhinney have traveled more than 5000 miles to photograph champion dogs in shows and kennels and the prints represent breeds from every part of the world except India.

Synthetic Snow

CORN flakes were used by Castle Films in a recent 16mm movie, made for amateur projection, to simulate the appearance of snow. The effect looked realistic and completely convincing. The reproduction shows one scene from the movie in which the stunt was employed.

Snow on the Window

Our Contest

A COMPLETE report of the results of the Sixth Annual Scientific American Photography Contest will be found on page 104 of this number. Although a total of 36 prizes, valued at over $1100, was awarded, space limitations do not permit us to reproduce all of the winning pictures. Thus we are presenting only the first-prize pictures in the three divisions. Names of the successful contestants, however, together with their geographical distribution, are given on the page mentioned above.

Color Cartoons

OWNERS of 8mm and 16mm motion picture projectors may now purchase color cartoon films for home projection, according to an announcement by Castle Films. The company announces "the successful reduction and duplication of color prints for the first time for home movie fans."

Costing no more than the price of unexposed color movie film, the new films bring to home screens the variety and added interest of commercial color fun cartoons produced in Hollywood, reduced for home projection. The first subjects include "Jack Frost," "Aladdin's Lamp," "Old Mother Hubbard," "The Pincushion Man," "The King's Tailor," and "Mary's Little Lamb."

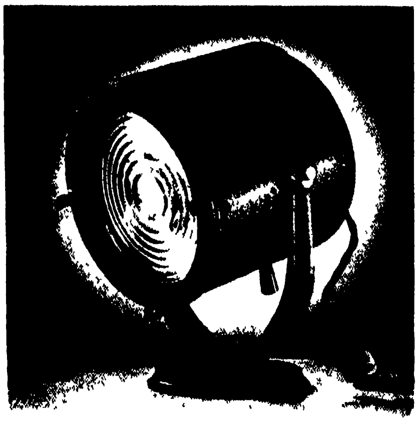
Films Train Defense Machinists

"CUTTING a Spur Gear," a 16mm sound movie film showing "the *what* of machine tool use, so a man can give his whole attention to the *how*," and prepared under the direction of the United States Office of Education as the first of a series of more than 50 machinist and industrial training films, is now available to industries, schools, and other organizations.

The film library channels of the Bell & Howell Company, Chicago, are being devoted to the loan and sale of copies, the company announces

Lighting Problem Solved

A NEW YORK CITY commercial photographer, John Muller, called upon to make a photograph for reproduction purposes of a new spotlight (the Fresnel Photospot described in What's New, this issue), achieved the fine result here shown by means of light exclusively and without the help of the retouching artist. The difficulty with this type of photograph is in the illumination of the black exterior so that it can be properly reproduced, at the same time illuminating the lens without burning up the carved details of the Fresnel pattern.



No retouching

For this particular job, six lights were used in all—three floods and three spots. One spot was directed on the background to create a small circle of light sufficiently large to surround the subject and provide the necessary separation from the background. Other lights were placed in front and in back of the subject. For the inside of the lamp itself, the regular projection bulb was removed and a projection bulb of the "built-in" reflector type (half-silvered) was used instead, with the silvered part turned around to face the reflector. The rest of the housing interior was covered with white paper. The illumination from the silvered lamp therefore struck the reflector first and was then diffused throughout the housing by the white paper lining, giving the desired non-directional result that illuminated the Fresnel lens softly and evenly.

Report on Pictorialism

IN PREPARING its annual report on pictorial exhibitions for the year July 1, 1940, to June 30, 1941, the 56th volume of the American Annual of Photography (1942), shows a perceptible drop in the number of exhibitors. For the tabulated year, the total number of exhibitors came to 7560, compared with 8928 for the year 1939-1940, and 13,746 for the year 1938-1939. Eleanor Parke Custis was found to have been the most prolific of all exhibitors during the period, with 146 prints shown in 55 salons. Frank R. Fraprie, who exhibited 118 prints in 54 salons, came second. Dr. Max Thorek was declared to be the most prolific exhibitor of the past five years, having shown 1053 prints in 317 salons. The highest rating of all exhibitors for the year went to Leonard Misonne, of Belgium. Harvey A. Falk, of New York City, took second place.

Uses for Glycerine

AIR bells on films during development may be eliminated by adding 1/5cc. of glycerine to each liter of solution, according to "Glycerine Facts," publication of the Glycerine Producers' Association. Another suggestion is the following formula for a print varnish, which lends brilliance and durability and is especially suitable for use on bromide prints:

Borax	30 grains
Pale shellac	60 grains
Sodium carbonate	10 grains
Glycerine	30 minims
Water	1 ounce

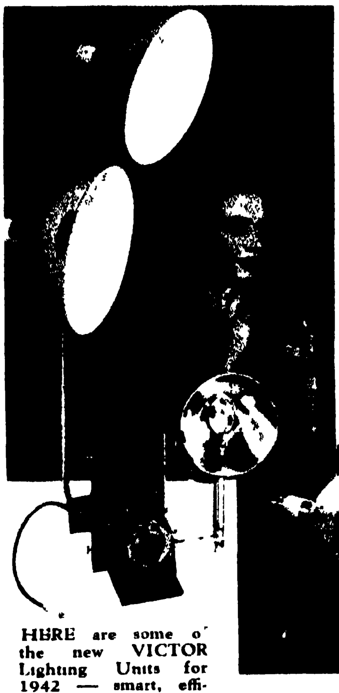
Boil and allow to cool, then add:

Alcohol	1 ounce

Add a small quantity of whiting or powdered punice to precipitate the gum wax. Shake well at intervals and allow to stand for several days. Decant and filter the clear liquid. Bottle until needed.

Club Program Planning

ALL work and no play makes camera-club membership a dull thing, is evidently the thesis serving as the basis of Agfa-Ansco's "Report of a Survey on Camera Club Program Planning," which the company offers gratis to all camera clubs. The programs, based on information gathered from 1300 leading camera clubs in the United States, are divided into infor-



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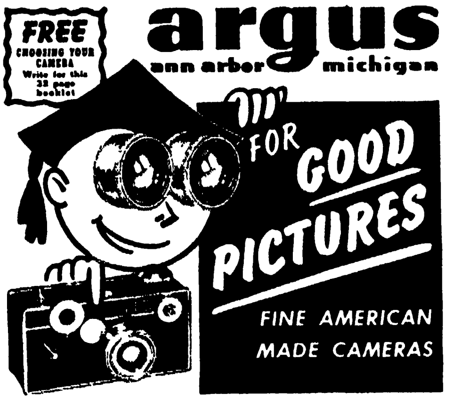

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"An outstanding exhibit of amateur photography." "The best display of its kind ever brought together." "The amateurs whose work was entered in this contest out-do the professionals at their own game." These and similar comments were voiced by those who viewed the exhibit of photographs from which the judges selected the final prize winners in the Sixth Annual Scientific American Photography Contest. These winners can take justifiable pride in their success, since they were up against stiff competition.

Space permits reproducing only the three first prize winners and a list of the names of the others who earned awards. Needless to say, the reproductions do not do full justice to the originals, yet so fine was the photographic quality of them that it is retained to a great degree even when the pictures are greatly reduced in size.

First Prize—Division I

Division I

First Prize: **Dr. Irving B. Ellis**
Piedmont, California
Second Prize: **Edward Canby**
Dayton, Ohio
Third Prize: **W. J. Harvey**
Hollywood, California
Fourth Prize: **Truman B. Gordon**
Oil City, Pennsylvania
Fifth Prize: **Mrs. Eldean Olsen**
Santa Monica, California
Sixth Prize: **A. J. O. Romero**
Bronx, New York
Seventh Prize: **Arthur VanVictor**
Detroit, Michigan

Honorable Mention
Henry M. Blatner
Albany, New York
Burnis McCloud
Denver, Colorado
Arthur E. Haug
Chicago, Illinois
Mrs. Eugene Landess
Fayetteville, Tennessee
William Dennin
Chicago, Illinois

Division II

First Prize: **Robert Desme**
Brooklyn, New York
Second Prize: **James Jenkins**
Arcadia, California
Third Prize: **Janet Weston**
Atlanta, Georgia
Fourth Prize: **Mrs. Allen L. Sutter**
San Francisco, California
Fifth Prize: **John Hansen**
Brooklyn, New York
Sixth Prize: **Dr. I. K. Moorhouse**
Beaumont, Texas
Seventh Prize: **Edward L. Gockeler**
Saranac Lake, New York

Honorable Mention
J. P. Whiskeman, Jr.
Van Nuys, California
W. Brooks Hamilton
Lexington, Kentucky
B. W. Leroy
Portland, Oregon
Tom Peterson
El Paso, Texas
Thomas O. Sheckell
East Orange, New Jersey

Division III

First Prize: **L. C. Sefing**
Allentown, Pennsylvania
Second Prize: **Allen L. Sutter**
San Francisco, California
Third Prize: **Tyrus T. Tanimoto**
Honolulu, T. H.
Fourth Prize: **La Vern Frost**
Crystal, Michigan
Fifth Prize: **Harold B. Stoddard**
Westfield, New Jersey
Sixth Prize: **Charles Brennen**
Trenton, New Jersey
Seventh Prize: **Dr. S. A. Bobrov**
Ossining, New York

Honorable Mention
Elmer L. Onstott
St. Louis, Missouri
Hilda Ferguson Hampfler
Kennett Square, Pennsylvania
Charles H. Mundorf
New York, New York
C. W. Mattison
Camp Hill, Pennsylvania
C. Chester Lasell
Oneonta, New York

First Prize—Division II

First Prize—Division III

mal and formal programs, the former participated in by all members, the latter conducted by a single person or small group. The report includes detailed plans and suggestions for more than 40 ideas that have been tested and found successful.

In its survey, the company found that membership ranged from a group of three or four all the way to 20,000, the latter claimed by KYW Camera Club. The Railroad Camera Club, with a membership of 12,000, and the Kodak Camera Club, with 2064, came next in the list. In all it was found there are more than 5000 camera clubs in the country, the bulk of the clubs having a membership averaging 25 to 50 members.

Cork Efficiency

A CORK can be a useful article only if it is properly handled. If you have had trouble getting a cork to stay firmly in a bottle neck, try soaking the cork in melted paraffin. You will find the cork will then fit better and last longer.

Club Auction

THE problem of surplus equipment owned by its members was recently solved by a local camera club by inaugurating the idea of periodic auctions. At these sessions, the members bring in whatever equipment they find they no longer have any use for, and the items are sold to the highest bidder. Outsiders are invited to participate. The result has proved generally satisfactory to both seller and buyer.

"Repair That Camera"

TO MAKE the most of what you have, in view of national defense demands, the Eastman Kodak Company is urging a "Repair That Camera" campaign for American photographers.

"There are 19,000,000 cameras in active use in the United States, and there are probably more than 5,000,000 others on shelves, in closets and bureau drawers," a Kodak executive states. "Although there may be a shortage in some types of cameras, there's no reason why these older units cannot be brought back into service and put to practical use."

A 25-percent reduction in repair costs on all Kodaks during the months of January, February and March, is announced by the company to start things going.

● ● ●

WHAT'S NEW

In Photographic Equipment

FRESNEL PHOTOSPOT ($12.98; standard 500-watt projection lamp, $1.98 extra): Designed for spot, flood, and combined effects, with bulbs available for black-and-white and color photography. Features: focuses 1-foot diameter spot to 6-foot diameter flood at five feet, projects intense, soft edge beam without lines or color fringes; takes 300, 500, and 750-watt projection bulbs, long-life (500-hour) 500 watt bulb, and special 500-watt 3200° Kelvin lamp for Kodachrome; provides full control of shadow edge, soft to sharp; all-steel welded body, ample ventilation for any burning position; six-inch diameter heat resisting Fresnel lens; 4½-inch chrome reflector; heat-insulating Bakelite handles; may be mounted on tripod, 10-foot cord, switch, and plug; dimensions (on base): 8 inches wide, 10 inches long, 11 inches high, weighs 9 pounds. Various accessories, including light stands, masks, special color kit for color control, light stand adapters, and so on

EXTENSION FLASH HOLDER FOR KODAK SENIOR SYNCHRONIZER, MODEL E ($14.55): Equipped with rubber insulated cord for extension to 20 feet from camera. Similar to battery case, equipped with ball joint and clamping bracket having rubber pads. Flash bulbs may be operated from release of synchronizer or extension holder.

WESTINGHOUSE LAMP DISCOUNTS Fifteen percent cut from list price on purchase of carton of any one of 17 Westinghouse Mazda photoflash or photoflood lamps. Midget bulbs cut from 13 to 11 cents each when bought in cartons of six.

WABASH INFRA-RED HEAT LAMP ($2). For darkroom and studio use Color pigmented into glass. Action of rays starts drying process of film and paper from inside out. Made in 250-watt size, natural ruby glass, with burning life of 6000 hours. Suggested uses speed drying of ferrotyped prints or prints on blotters, quick drying of single films or roll film; heating solutions; drying tanks, reels, and so on.

CRAIG FIRE-STONE WATER FILTER ($3.75): Operates regardless of power or water pressure. Has two fittings to accommodate all faucets. Extra filtering stone. Metal parts triple chrome-plated to guard against corrosion. Maximum flow of two gallons per minute.

KODAK DENSIGUIDE ($1): Compact calculator for estimating gray scale densities on suitably prepared negatives. Especially useful in making color separation negatives and color prints.

NEW WESTON RATING BOOK (10 cents): More permanent form includes 16 pages, 2½ by 3½ inches, printed in two colors and bound with laminated finished stock.

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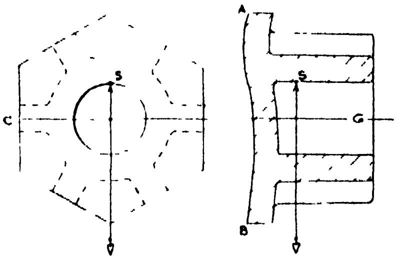
LAST month, in this department, Dr. J. A. Anderson, physicist at the Mount Wilson Observatory and Executive Officer for the 200" mirror now being completed at the California Institute of Technology, began a two-part article describing the work of the past five years on the mirror. This month he completes the description. This is the first detailed technical revelation of the difficulties that have arisen in the long years of work on the big Pyrex disk, and of the methods used in defeating them.

Three years ago this department urged Dr. Anderson to describe what was going on, also to state when the work would be finished. He wisely replied: "Dates I can not give yet," and he added, "I shall refuse to describe a job until it is completed, but you may be sure that my article will be in your hands within ten days of the completion of any one stage." This promise was kept recently when the stage of bringing the surface to a sphere, preparatory to parabolizing and figuring, was completed. The account proves to be something of a now-it-can-be-told story, for there were troubles. Yet anyone who has ever made even a small telescope mirror could have predicted this — there always are troubles, some of them almost interminable; while in pioneering a mirror of unprecedented size, such as the 200", they were all the more expectable. Those that were encountered now turn out to have been even more puzzling than the best of the tales circulated orally by "Old General Rumor." Yet they were conquered and the project moves successfully toward completion — when? This still is unknowable — for a telescope mirror is finished when it is finished. Dr. Anderson's account, continued from last month, follows:



Drawings by Russell W Porter

Figure 5: **Theoretical hexagon**

"Optical tests of the 200" mirror were at first made with the mirror tipped up so its optic axis was horizontal, using therefore only the one component of the supporting levers. Later on, tests were made with the axis pointing about 4° above the horizon, so that both components of supporting force would be in action. In the later stages of figuring the mirror was made to rest on the supporting system while polishing was in progress.

"The first optical test of the mirror, in September 1938, revealed a fair spherical surface with some zonal and other errors, the chief of which was astigmatism. Measurement of the latter showed that the radius of curvature of a vertical plane was a millimeter or so shorter than that of a horizontal section. Rotation of the mirror about its axis in the testing position showed that the astigmatism did not rotate with it — in other words the radius of curvature in the vertical plane remained shorter in all positions of the mirror.

"More refined measures revealed another surprising fact — namely, that at times the vertical astigmatism would have slightly different values in two orientations 180° apart. Running down the cause of this behavior required considerable time after it had been demonstrated to our satisfaction that the phenomena were real and not simply errors of measurement. A linear astigmatism of the order of 0.05", with a not very smooth mirror surface where errors of measurements would average 0.01" or 0.02", does not seem so very bad — and the 180° effect of about 0.01" might very well be considered accidental — as it was in fact until continued improvement in the figure reduced errors of setting to a few thousands of an inch. Anyway, both of these effects which had been noted in the early tests turned out to be real and correctable, though it must be confessed that it took a year or more to discover their nature and cause.

"The cause of the vertical astigmatism lies in the structure of the mirror itself, combined, of course, with the method of internal support. Suppose the mirror is tipped up so that its axis is horizontal. Its weight then is carried by the 36 levers whose points of contact are in the rib structure and something like four or five inches behind the continuous front of the mirror. Let us think of one of the hexagons (Figure 5), into which we divided the mirror in the previous discussion, as made up of two parts: first, the solid front curved plate and second, the ribs. The front plate is about twice as stiff in a vertical plane as the rib system is.

"If now the support point were located at the center of gravity (actually, on the axis of the 'pocket'), the half of our unit below the center of gravity would be in tension, so that it would stretch; while the part above would be in compression. Also, the deformation of the ribbed part would be twice as great as that of the solid front. If the undeformed front surface were a plane, it would, under this deformation, become slightly S-shaped vertically; that is, the upper half would be slightly convex, the lower slightly concave. Since, instead of a plane, we have a spherical surface in the undeformed condition, the deformed condition will consist in the addition of a very weak convex cylinder to the upper half and a similar concave cylinder to the lower half of the unit. Taking now the whole mirror, each of the 36 parts would be similarly deformed, but there would be no general deformation of the surface as a whole.

"Return now to the actual case. See Figure 5. The supporting point is on the upper surface of the 'pocket', which lies some 6" or 6½" above the center of gravity. The part *A* that becomes convex is therefore 6" shorter than the lower part near *B*, which becomes concave. So we may say that, on the whole, the unit is concave; and when we now add up the 36 parts we find, in addition to the local deformation of each unit, a general (net) vertical concavity of the whole surface, which is what has been observed. The diagrams of Figure 5 will perhaps aid in under-

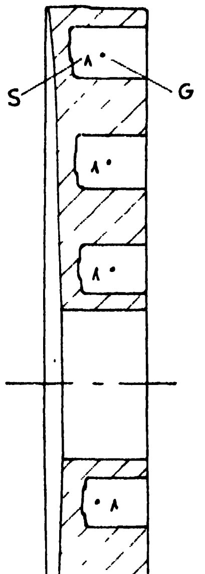


Figure 6: **Cause of astigmatism**

standing this. The local deformations of each unit are of course present, but they are so very much smaller than the net deformation that, provided the latter is small, the former will be too small to be observed.

"If, in Figure 5, the support *S* could be located on line *CG*, curve *AB* would be symmetrical about *CG*, and the net curvature of *AB* would be zero.

"Clearly the effect just discussed will be absent, or have zero value, when the axis of the mirror is vertical. As the mirror axis is tilted toward the horizon, the effect will vary as the sine of the zenith distance. To correct it, a system of 12 gravity-operated 'squeeze levers' were applied, acting on the outer edge of the disk near the back, which, when the axis of the mirror is horizontal, act so as to correct the error. Since their effect also varies as the sine of the zenith distance, the compensation will be correct in all positions of the axis.

"The second phenomonen mentioned above—that is, vertical astigmatism in two orientations 180° apart—is caused by a maladjustment of the supporting levers, and, like the one just discussed, is absent when the mirror faces the zenith. Let us again consider the mirror tipped up, with axis horizontal, and assume that the supporting levers such as *S*, Figure 6, in the upper half are on the average so adjusted that their supporting points are somewhat in front of the center of gravity surface in the mirror, while those of the lower half are misplaced in the opposite direction. Reference to the same figure will make it clear that, in the assumed position, the radius of curvature in the vertical plane will be lengthened, while if the mirror is rotated 180°, the radius will be shortened by the same amount. Here the remedy is obvious.

"In order to test for astigmatism when the mirror faces the zenith, the arrangement shown in Figure 7 was employed. The light source and the knife-edge are, as usual, near *CC*. The plane mirrors *MM*, at 45°, are 8" in diameter. By rotating the large mirror the zone indicated by the dashed line may be tested for astigmatism. By adjusting the counterweights of the 'lifting component' of the supporting levers, any observed small amount of astigmatism may be removed.

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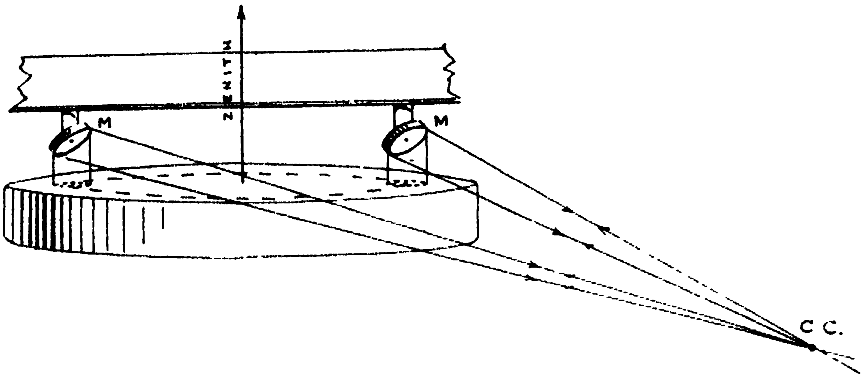

Figure 7: **The method for testing by zones for astigmatism**

center of curvature, using a method worked out by Dr. F. E. Ross and the author. The method is new as far as we are aware; however, it would not surprise us if it should prove to be 'old as the hills' — for no complete search of the literature has so far been made. The method is shown in Figure 8. The lens *L* is so designed that, when the light source is placed at a point between its focus and the lens, the spherical aberration at its virtual conjugate focus is such that the conjugate focal points for different zones of the lens coincide with the 'centers of curvature' of the corresponding zones of the paraboloid. The light source is shown on the axis. To the right of the lens the rays travel along the normals to the paraboloid, whence they are returned along the normals and would converge to the source — but, by the aid of the half-silvered plate *P*, the returning light is brought to the knife-edge as shown The source and knife-edge may be interchanged

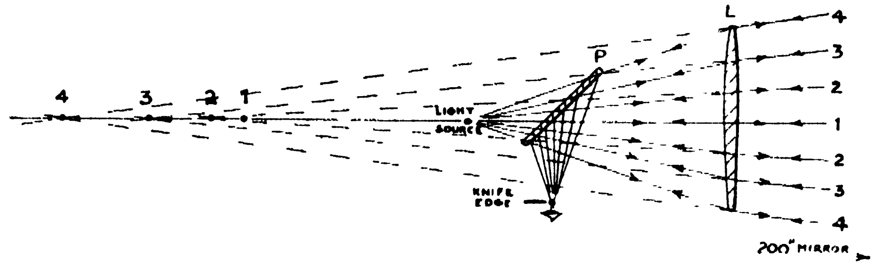

Figure 8: **Testing method to be used in the final figuring**

"The author wishes to express his deep appreciation of the assistance given him by Russell W. Porter in the preparation of this article."

Ever make a flat? Then you know the application of this verse, written by Anon Y. Muss:

An old man who lived in a cave
Knew how to make fringes behave.
If he moved his head closer,
And the fringes grew grosser,
He knew that the work was concave.

If as sometimes asserted, metal mirrors are inferior, optically, to mirrors of glass, they have certain special uses which justify them, and some like them anyway. Sidelight is thrown on their optical quality in a paper by Sydney J. Needs, Philadelphia, published in the "Transactions of the American Society of Mechanical Engineers" for May 1940, wherein he states that "there appears to be no metal which, when polished and examined even under low powers of the microscope, will present a surface of uniform appearance even remotely approaching that of well-polished glass."

Needs is not an amateur telescope maker but an engineer who undertook an extended research on the influence of boundary films of lubricant in machine bearings, and performed his experiments between two circular metal flats. In order to prepare for these experiments he first had to learn, from scratch, how to make the flats used in it, and in this he was aided to some extent by "A. T. M." (The pun about "from scratch" was unpremeditated but any who have been through the mill would perhaps vote to leave it in.) Needs continues:

"The metal surfaces invariably contained pits or non-metallic inclusions, iron carbides or traces of manganese in the form of gray spots with well-defined but irregular edges. Experience finally seemed to indicate that the best surfaces were produced by high-speed tool steel or a high-chrome tool steel. The chrome steel is corrosion-resistant and will hold its shape over long periods of time but it warps badly during the hardening process and is somewhat difficult to polish."

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(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

United States Imports as Possible New Crops for Experimentation is a detailed, 32-page list of crops worth considering for trial and possible large-scale cultivation, with the amount of each item imported and the country of its origin, also the price paid. Spices, drug plants, condiments, and odd items that may now become scarce and be worth growing as side items. *National Farm Chemurgic Council, 50 West Broad Street, Columbus, Ohio.—25 cents.*

Casco Projects is a 14-page booklet which describes a series of home workshop projects for the construction of various types of furniture *Casein Company of America, Department CP, 350 Madison Avenue, New York, New York.—Gratis.*

Watson-Stillman General Bulletin No. 110-A is a 44-page catalog describing a line of self-contained, high-speed hydraulic machinery and equipment. Descriptive illustrations are presented on presses, pumps, jacks, and high-pressure valves. A section contains selective engineering tables pertaining to hydraulic problems. Request this bulletin on your business letterhead. *Watson-Stillman Company, Roselle, New Jersey.—Gratis.*

Wabash Exposure Bulletin, is a four-page compilation of data on lighting with flash and flood, for black-and-white and color, brought up to date to October 1, with bulletin No. 740P. *Wabash Photolamp Corp., Brooklyn, New York.—Gratis.*

Hardsteel Drills is a pocket-size booklet which gives information on a new type of drill which can be used for working hardened steel. The text includes instructions for use of these drills and for resharpening the various types. It is claimed that these drills can be used on armor plate, spring steel after tempering, and even for drilling holes in files. *Black Drill Company, 5005 Euclid Avenue, Cleveland, Ohio.—Gratis.*

Standard Carbide Tools Stock Sizes is a four-page bulletin giving complete specifications for 92 different types and sizes of these tools. In this line are available tools with tips of Vascoloy, Carboloy, Kennametal, and Firthite. *Tungsten Carbide Tool Company, Detroit, Michigan.—Gratis.*

Your Wings is a beautifully produced 32-page booklet which describes in some detail the services offered by one of the major airlines of the United States. Some historical background is given, with photographs of early plane types, and present-day operating methods are described. This booklet will interest every reader who wants to know more about our vital air transport system. *United Air Lines Transport Corporation, Municipal Airport, Chicago, Illinois.—Gratis.*

The Kodak Data Book of Formulas and Processing is a 65-page booklet, just issued by the Eastman Kodak Company as the latest in their list of Kodak Data Books and Kodaguides. All the Kodak formulas are covered in the book, which also includes the "why" and "how" of developing and printing. *Eastman Kodak Company, Rochester, New York.—25 cents.*

Pioneering the Cathode-Ray and Television Arts is a 32-page pamphlet describing the work of one organization which has been actively associated with these arts for the past decade. It gives a broad view of the cathode-ray tube in its many applications and of its special use in television reception. *Allen B. Du Mont Laboratories, Inc., Passaic, New Jersey.—Gratis.*

Industrial Brush Bristles is a 14-page pamphlet describing and illustrating a wide variety of uses for nylon bristles. Included in the booklet are samples of these bristles. Request this booklet on your business letterhead. *Plastics Department, E. I Du Pont de Nemours & Company, Arlington, New Jersey.—Gratis.*

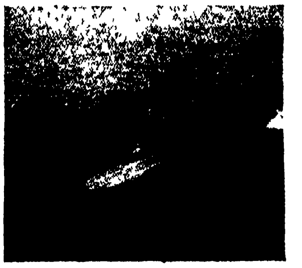
Condensation of Moisture and its Relation to Building Construction and Operation, by Frank B Rowley, Axel B. Algren, and Clarence E. Lund, is a 70-page technical bulletin which considers the subject of its title in both insulated and uninsulated houses. Request Bulletin No. 18. *University of Minnesota, Minneapolis, Minnesota.—40 cents.*

Photography as an Extra-Curriculum Activity, by C. B. Neblette, is an eight-page folder available to teachers and school administrators. *Rochester Athenaeum and Mechanics Institute, Rochester, New York.—Gratis.*

Climate and Man is the 1941 Yearbook of the United States Department of Agriculture, and this year its 1248 pages are devoted entirely to weather and climate, largely in relation to crops but still so broadly as to be of value to all country-minded persons. It contains detailed data on the climate of each state. *Superintendent of Documents, Washington, D. C.—$1.75.*

Trains is a year's volume of a new magazine devoted to subjects of interest to railfans, now in its second year of publication. Contains an index of the articles published in the 12 bound numbers. *Kalmbach Publishing Company, 1568 West Pierce Street, Milwaukee, Wisconsin.—$2.50.*

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.



FLOATING airports of the Navy — plane carriers — will total 18 when the present Navy program is complete. Each will have a complement of 160 pilots and will carry from 70 to 90 planes. Our cover illustration, an Official United States Navy photograph, shows a plane being launched from the *Saratoga*.

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SCIENTIFIC AMERICAN AND WAR

War—all-out war, total war, call it what you will—is reaching deeply into the very lives of every resident of the United States of America. There is no phase of existence that modern warfare does not affect And while it is not news to tell of the inroads that war-time production is making on civilian materials of all kinds, it seems proper to record here some of the things that are happening or are in prospect and which will influence the future course of this magazine.

Physically, a magazine consists merely of ink on paper, and it is the paper that you can hold in your hand, see the color of, feel, and—if you want to—taste. That is, the paper itself is really the physical material that you buy when you obtain your copy of Scientific American. Here is where you will notice the first change. The color of the paper—it is white, but there are many degrees of whiteness in paper—will incline more toward a natural or yellow shade. This is due to restrictions on civilian uses of chlorine, the chemical that is used to bleach the pulp from which paper is made. Then, too, we have already been restricted in the amount of paper which can be bought during 1942—a serious situation when circulation figures are climbing.

What are we going to do about it? In the matter of paper color, there is nothing that can be done. We can only exercise every effort, with the assistance of the printer, to achieve the best possible printed result with the paper available. As to quantity of paper. There is every hope that the restrictions will not be too drastic but it will undoubtedly be necessary in some of the issues of 1942 to reduce the number of pages This will, of course, be done only as a last resort, but already steps have been taken to make up, at least in part, for any such restriction As will be noticed, the issue now in your hands is set in a different type from that of previous numbers This new type, while just as readable as the former font, is a bit more compact; as a result it is possible to get about 10 percent more words on a page. Thus, as long as we are able to maintain normal size, the reader will get the benefit of more text; when reduction of pages becomes necessary, if it does, the net result over a period of months will just about balance

MILTON WRIGHT

On December 29, 1941, Milton Wright, formerly an associate editor on the staff of Scientific American passed away at his home in Freeport, Long Island. Mr. Wright, who was connected with this magazine from 1925 to 1929, will be particularly remembered for his outstanding articles on successful but little-known inventors in the United States. From 1929 to his death, Mr. Wright devoted his energies to writing and lecturing on business procedure and psychology. His passing has left a definite gap in that group of former associates of the editorial staff who, while going into other fields, have remained firm friends of Scientific American.

Then, too, photo-engravings, from which photographs and drawings are reproduced, use copper, zinc, and a number of chemicals; the metals are strategic materials needed for military purposes, as are also some of the chemicals. How soon photo-engravers will be curtailed in their operations, due to inability to obtain their necessary supplies, is not yet known. When and if this does happen, it is obvious that fewer and fewer illustrations will grace the pages of all magazines.

In any event, and no matter what happens, the publishers of Scientific American pledge that the magazine will continue on the same high plane that it has occupied for the 97 years of its existence. Nothing will be permitted to interfere with the character of the editorial content When it comes to belt-tightening in the material things of production over which we have little or no control—and we hope that any such belt-tightening will not be drastic or long-lasting—we trust that our readers will understand the reasons for it and will continue to lend the loyal support that has always been the pride of the publishers of one of the oldest magazines in the world —*A. P. P.*

THE PATENT OFFICE MOVES

It seems strange that, in a country built on an industrial foundation, which foundation in turn is based on the bedrock of a patent system second to none in the world, even the emergency of war should be allowed to interfere with the smooth functioning of the Patent Office. Yet just that is being done, despite the fact that the operations of the Patent Office assume vastly increased importance to the welfare of the nation in times of war

What actually is being done is that part of the Patent Office is being moved from its convenient and well-designed quarters in Washington to an old tobacco warehouse down in the freight yards of Richmond, Virginia Reason? Vice President Wallace, recently made Chairman of the Economic Defense Board, wants the present housing facilities of the Patent Office for his agency And he is getting them.

At the time of writing it appears that files of patent and trade-mark copies will be kept in Washington for purposes of conducting searches. Patent applications and amendments will continue to be filed in Washington, after which they will be transferred to Richmond That this procedure will throw an added burden on an already overworked Commissioner and executive staff goes without saying That it will slow up the intricate and time-consuming tasks of the entire Office is equally obvious.

An integrated Patent Office is essential to the economic structure of the entire nation. Even the sacrifices made necessary by national emergencies should be carefully weighed before deciding upon such upsetting and radical changes. Surely there are other government agencies that could better be put to inconvenience than the Patent Office How about the Economic Defense Board itself?

It is to be hoped that, costly though it would be in time and money, the error of this change will soon be detected, and the Patent Office will once more be restored to a unit basis.—*O. D. M.*

Personalities in Industry

ALFRED P. SLOAN, JR.

OFTEN referred to as an outstanding example of the new school of corporation executives, Alfred P Sloan, Jr, Chairman of the Board of General Motors Corporation, has expressed his industrial philosophy in the following manner.

"My objective is to impress the vital necessity of searching aggressively, and with an open mind, for the fundamental truths in the broader relationships of industry to society; the separation of truth from the fallacies; and the promotion of the broadest possible understanding on the part of all people as to the effects of these fundamental truths on industry's ability to accelerate human progress. Industry must further expand its horizon of thinking and action. It must assume the role of an enlightened industrial statesmanship."

Mr Sloan was born in New Haven, Connecticut, May 23, 1875 When Alfred, Jr, was five years old, his family moved to Brooklyn, New York Before completing his high-school education in Brooklyn, young Sloan gave up his regular studies and took special instruction to prepare for college. He was disappointed when he found that he could not enter college immediately, because he was too young. A short time later he entered the Massachusetts Institute of Technology, where he completed a four-year course in three years. He was graduated with a degree of Bachelor of Science as the youngest member of his class.

Young Sloan began work as a draftsman with the Hyatt Roller Bearing Company in Newark, New Jersey. At this time the automobile industry was becoming more active. Experience proved that a steel axle bearing of the roller type was needed Mr Sloan worked on the bearing invention of John Hyatt, found funds to finance the project, and went on the road to sell the bearings From the start Mr Sloan's activities brought him into direct contact with automobile leaders and the years which he devoted to the activities of the Hyatt Roller Bearing Company gave him a diversified schooling in many phases of the automobile business He gained an intimate knowledge of draftsmanship, designing, engineering, production, sales, advertising, and executive direction

Because of his aptitude for organization and his penetrating business sense, Mr Sloan was named President of the United Motors Corporation, organized in 1916 In 1918 United Motors Corporation became a part of General Motors Corporation Mr. Sloan was named Vice-President of General Motors in charge of accessories and was made a member of the Executive Committee. He proved his ability to direct successfully the many activities of the Corporation and on May 10, 1923, he was elected President. Mr Sloan served in this capacity until May 3, 1937, at which time he was elected Chairman of the Board

A striking figure, well over six feet in height, Mr Sloan is broad-shouldered and lank. His face is long, narrow, and mobile; his skin clear and tanned, his eyes are set well apart, surmounted by a high forehead He has an attractive smile and a voice characterized by an almost Southern drawl at times. He is filled with nervous energy.

As an executive, Mr Sloan is a distinct contrast to the "sledge-hammer" business personalities of an earlier era. He does not lack force, but force is not his outstanding quality. He is a doer, but perhaps even more conspicuously, he is a thinker. His task is to deal with human relationships upon a vast scale, to study economic principles, to lay out policies for the permanent direction of his prodigious company. He combines in a most interesting way the qualities of a man of action and a philosopher.

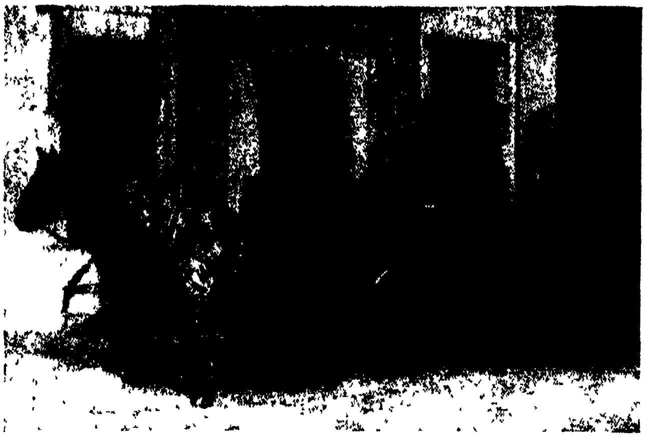
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of March, 1892)

CRUISERS—"The splendid steamer *Majestic* reached New York from Liverpool on the 24th ult., her average speed being 20.41 knots for the voyage, or about 23½ miles per hour. What the navy of the United States needs is a fleet of twenty-five cruisers like the *Majestic*, which in time of peace should be employed in active service, such as transport of the mails, thus keeping them always in effective condition."

GATLING—"The latest model of the Gatling gun, shown in the accompanying illustration, has been given the name of the 'Police gun,' from its admirable adaptation for police or mounted service, for guarding railway trains, banks, or safe deposit institutions, or for use on vessels, yachts or boats. Its weight is but 74 pounds, so that it can be carried if necessary by a single man, or, with all accessories for the field, on a single animal. It has six barrels, and the feed is positive, enabling it to be fired at the rate of 800 shots per minute at all angles of elevation and depression. When set up in the back part of a patrol wagon, and served by two or three men, it is designed to do more effective work in dealing with a mob or in dispersing rioters than could be accomplished by a whole company of infantry."



POWER TRANSMISSION—"In a recent lecture on 'The Induction Coil,' at the Royal Institution, by Prof. Fleming, the employment of transformers for raising or lowering the pressure of alternating currents was illustrated. . . . A current of electricity, supplied to the lecture table at a pressure of 100 volts, was raised to 2,000 volts by means of a Mordey transformer. At this high pressure it was sent across the room by means of two very thin wires; then reduced again in pressure to 100 volts by another transformer, and used to illuminate a large incandescent lamp. The lecturer pointed out that a great economy was effected in the cost of transmission of the energy by thus sending the current at high pressures."

RIVERS—"Geographers claim that there are twenty-five rivers on the globe which have a total length each of over 1,000 miles. Of these, two, the Mississippi from the source of the Missouri in the Rocky Mountains to the Eads jetties, and the Amazon from the source of the Beni to the isle of Marajo, are over 4,000 miles in length. To be exact, the former is 4,300 and the latter 4,029 miles from the source to the places where their waters are mingled with those of the ocean."

REQUIREMENTS—"The internal organism of the traveling salesman should be a mixture of mule, ostrich, and camel. Part mule, that he may be able to sleep on his feet if no better accommodations be at hand; part ostrich, that he may be able to eat and digest anything set before him; and part camel, that he may, if necessary, go a long time between drinks"

ALLOY—"The advantages of an addition of aluminum to fluid iron are important. With moderate care absolutely pure and solid castings can be obtained capable of receiving a high polish. An addition of aluminum is especially to be recommended for the manufacture of steam cylinders, engine castings, press cylinders, and generally for castings which are to be subjected to high pressure."

RESISTANCE—"'If you take a good conductor like copper, and run the temperature down, its resistance almost disappears at very low temperatures; hundreds of degrees below zero copper is almost a perfect conductor. If you heat it up, it becomes more and more resisting. Let us take glass—a good insulator—or any insulating material, and run its temperature up; it loses its insulating power, and if we run it up until it gets to red heat, it approaches a conductor; so that all substances are conductors when they are hot enough.'—*Prof. Thompson*"

AIR *vs.* ELECTRICITY—"Compressed air is, perhaps, the chief rival of electrical transmission. It is at present used chiefly in mines, where it is still a very successful rival of electricity, but from present appearances it is likely that it will gradually be replaced by the latter method. In Paris there is a large central station for the distribution of compressed air, and it seems to be in successful operation. It does not appear, however, that the advantages over electrical transmission are so great that it will not soon be replaced by electricity. Its introduction is not making the rapid strides that the introduction of electricity is now making."

GEMS—"Unfortunately, for some reasons, the sapphires of Montana have slipped through the fingers of the people who should own them, and are now mined by an English syndicate, that has paid in $2,000,000, the best stones being sent to London, where high prices are demanded for them. The diggings are known as the Spratt sapphire ground, and are about twelve miles north of Helena, on the Missouri River"

DIGESTIVE—"Pineapple juice is an acid fluid of specific gravity of 1.043 An ordinary pineapple yields 600 to 800 cubic centimeters of it. The proteid-digesting power is quite remarkable in its intensity. Three ounces of the juice will dissolve ten or fifteen grains of dried albumen in four hours. The action takes place in acid, neutral, or even alkaline media, thus resembling trypsin more than pepsin . . . A well-known meat powder is said to be prepared with the help of pineapple juice."

CIRCULATION—"Blood travels from the heart through the arteries ordinarily at the rate of about twelve inches per second; its speed through the capillaries is at the rate of three one-hundredths of an inch per second."

PSYCHIC (?)—"A mysterious ringing of electric bells in a Swiss house was traced to a large spider, which had one foot on the bell wire and another on an electric light wire"

98TH YEAR SCIENTIFIC AMERICAN MARCH 1942

FOOD FOR BRITAIN HELPS US

An Apparent Paradox in Modern Nutrition

T. SWANN HARDING

When the first 2,000,000 selectees had been examined for the draft, exactly half of them were turned down for poor physical condition. About one third of this disability was attributed to malnutrition. The Department of Agriculture chimes in and says that only one fourth of all our families customarily have good diets, something over a third have fair, and the rest have poor diets.

Then, right on top of that, came an announcement in November, 1941, that we had sent to Great Britain 2.2 billion pounds of cheese, dried milk, evaporated milk, pork, lard, eggs, and other food, between April and November 1, 1941. Furthermore, it was stated that we planned to send Britain enough food in 1942 to fill a freight train that would reach clear across the United States. That food would supply one fourth of the British people.

Now does all that make sense? Isn't there a paradox here? Actually it does make sense but, like everything in modern civilization, the subject is complex

First off, it is true that we Americans, though fed better than any other people on earth in history, have not been well fed That means we have not all had a "best adapted diet," as the nutrition scientists say—a diet containing ample protein, calcium, phosphorus, iron, vitamin A, thiamin, ascorbic acid or vitamin C, and riboflavin.

The survey made not long ago by Hazel K. Stiebeling and her aids of the Bureau of Home Economics indicated that almost one third of our people live on poor diets. Underfeeding extends also to farm people, only half of whom have really good diets, while one fourth have fair and one fourth poor diets. The reason for that is that so many single-crop farmers fail to grow a part of their own food, a step the Department of Agriculture now urges them to take.

Approximately 64 percent of our non-relief people in villages and cities are in families with annual incomes of $1499 or less, and can afford to spend only from 6 to 10½ cents per person per meal for food Families with annual incomes of $499 or less can spend but 6 cents, those with incomes between $1000 and $1499 can allow about 10½ cents, but in families with incomes between $3000 and $4999 a year, this sum goes up to 18 cents How much, then, does it cost to buy an adequate diet?

HEALTH SCIENCE

American soldiers get a complete, well-balanced, but not over-fancy diet. A soldier's weekly food allowance includes: 4 pounds, 6 ounces of fresh beef; 14 ounces of chicken; 1 pound, 12 ounces of fresh pork; 9 pounds, 3 ounces of fresh and canned vegetables; about 1 pound of cereals and dried vegetables; about 2 pounds of fresh and canned fruit; 14 ounces of coffee; and 7 eggs. The Army spends 21 cents per soldier per meal, retail prices, for that ration.

You can readily make your own comparisons from the figures above. It is also of interest that the weekly allowance of the British in October 1941 was 7 ounces of meat, 3 ounces of cheese, 4 of ham and bacon, and 1 egg, plus certain other unrationed items.

The monetary and social cost of this malnutrition is huge. What we Americans could do if we were all well fed surpasses our wildest dreams Malnutrition destroys nerve health, lowers work efficiency, impairs learning power. For many years we spent hundreds of millions trying to educate children who were too far gone in malnutrition to learn. They were retarded in their work. It took twice as long to get them from one grade to another as it should have, and that points to plain extravagance.

Public attention has now been drawn by the National Nutrition Conference to such facts as these—facts which nutrition scientists had known for years. One physician, for example, announced in 1929, as a result of his own investigation, that one fourth the school children in the United States were suffering directly from malnutrition. That was 4,000,000 underfed youngsters. He said that one third of the Chicago school children and two thirds of those in New York were afflicted with nervous disorder, which often accompanies malnutrition. About 14,000,000 children then had defective teeth, another evidence of undernourishment.

Yet numerous studies both here and in Great Britain have shown that supplementing the ordinary diet of underfed children with a pint or so of milk a day will alone produce mental alertness, normal activity, improved learning capacity, and all-'round well-being and efficiency. This frequently happened when the child's previous diet was supposedly a good one Indeed, Sir John Orr said not long ago in a speech in Washington, D C., that undernourished women become "co-operative" when properly fed, and that is really something

Not even intelligence is a constant, nor is it a purely hereditary characteristic A decade ago Dr John Monroe demonstrated that many low-grade intellects become normal or even high grade when the stomachs of their possessors get an eggnog (no rum, please) twice daily to stoke up on.

Fatigue and nervousness are not necessarily unavoidable, or incurable, either. In this connnection consider 11 white women at Mayo Clinic who were the subjects of an experiment. The idea was to find out what happened when people didn't get their thiamin, or vitamin B_1. So these women, who normally did ward housekeeping, laundering, and sewing, were fed the following thiamin-deficient diet:

White bread, corn flakes, potatoes, polished rice, sucrose, skim milk, beef, cheese, egg white, butter, vegetable fat, cocoa, gelatin, canned fruits and vegetables, and coffee. The diet was supplemented with brewer's yeast, halibut-liver oil, vitamins C and D, iron, calcium, and phosphate, but it contained only about 0.45 milligram of thiamin daily, which is so little that we may ignore it. What happened?

Nothing—for about three months—then plenty. Then capricious appetites appeared, with nausea, vomiting, anemia, loss of weight, lowered basal metabolism, and "changes of behavior and other objective evidences of psychosensory and psychomotor disturbances, not manifested during the period of preliminary observations." In short, the good ladies got so irritable, quarrelsome, and inefficient that they couldn't do their work.

They became weak, inattentive to details, confused in thought, uncertain of memory. They lacked manual dexterity and began to fight and argue with each other all the time. But once thiamin was sneaked into their diets these disturbances ended and they could go back to work. It took only a milligram or two of thiamin daily to do that, too, and there are a thousand milligrams in a gram—which itself is about one thirtieth of an ounce. Fancy that hair line between healthy efficiency and complete uselessness.

If people are to fight an enemy or to work in a factory or on a farm upon defense projects, they must be well fed. The Nazis have been very careful to see to it that all Germans who do anything of importance get a complete, if somewhat monotonous, diet. But they have deliberately used malnutrition as an instrument of political action in the territories they have subjugated. For if people are kept underfed, they are too listless to revolt or to make much trouble. The British, on the other hand, say to us: "We can increase our production 25 percent more and lick the Nazis, too, if you Americans will surely provide us with the animal proteins needed to stoke our biological furnaces."

Since we are making of the British Isles an outpost in the effort to destroy Hitlerism, it is extremely important that the British be well fed. It is worse than useless to supply them with the guns, the ammunition, and the other instruments of modern warfare, if we deprive them of the food which alone can keep them in proper shape to fight a good fight.

But it is also important that all our own people be well fed. The basic freedom of the four mentioned by President Roosevelt is freedom from want. Unless people are well nourished they fail to appreciate freedom to worship as they please and freedom of speech; while fearfulness, or apprehensiveness, is one symptom of malnutrition.

Then what have we done for our own underfed? Through the Surplus Marketing Administration we have arranged to purchase huge quantities of food nearest the source, the basic producer, thus procuring it cheaply, and we have distributed this food to the undernourished—often, as in the school-lunch plan, utilizing idle labor to do this. Some food is purchased directly and then turned over to State welfare agencies. Some is used under the food-stamp, free school-lunch, and cheap-milk programs. Some farm commodities have been diverted to by-product or other uses.

Between October, 1933 and July, 1940 about $565,000,000 worth of farm products were bought from farmers and distributed to the needy in this country. This involved, among other things, 250,000,000 pounds of butter, 27,000,000 pounds of cheese, 76,000,000 quarts of fluid milk, and so on. In short, we have fed millions of our own half-starved people. Whatever happens in the future, we have decided, at least, that we cannot afford to let a generation grow up physically and mentally handicapped through malnutrition during childhood while we debate the form that basic social and economic reorganization should take.

What, then, of the future, and how does the better nutrition of American citizens tie in with food for Britain?

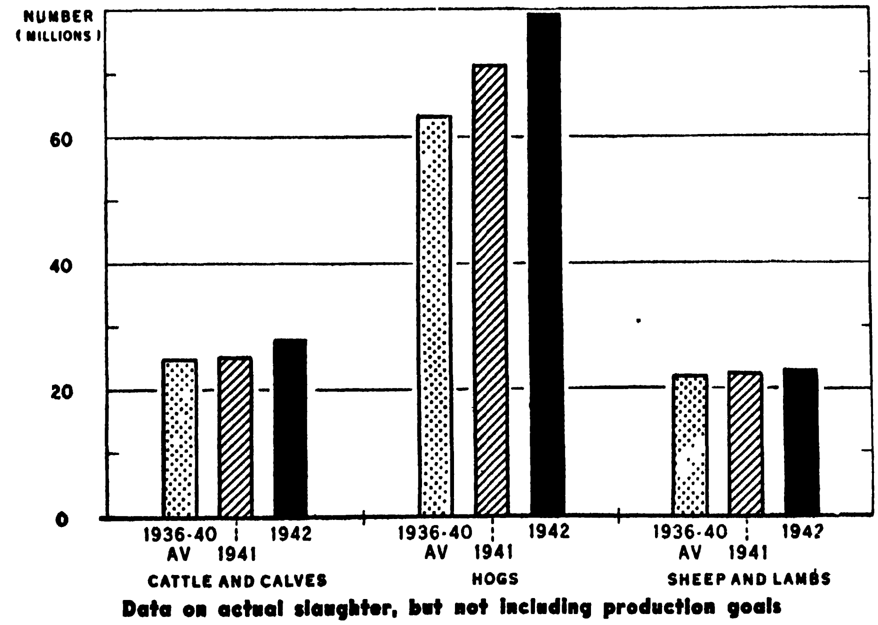
In September, 1941, Secretary of Agriculture Wickard announced the so-called food-for-freedom program. It involved the establishment of 1942 production goals for all essential agricultural commodities. These goals had been established scientifically on the basis of a thorough canvass of the needs of improved nutrition in the United States and the requirements of nations fighting Hitlerism. Every farmer will be contacted by his local committeeman in a nation-wide sign-up campaign.

The agricultural adjustment machinery will be utilized to increase the production of hogs and lard (by feeding Ever-Normal Granary grain to hogs), milk and milk products (by stepping up the grain feeding of dairy cattle), and eggs. Those are Great Britain's main requirements. At the same time the agricultural adjustment machinery will be used still further to curtail production of cotton, wheat, and tobacco, of which we have ample surpluses.

Shipments to Great Britain for 1942 will be simply stupendous—the equivalent of five billion pounds of milk, for example, in the form of dried milk, evaporated milk, and cheese—or enough milk to fill a pipe half a foot in diameter reaching around the Equator three times. The British will also get 1.5 billion pounds of pork and lard, representing enough 230-pound hogs, standing 1½ feet apart, to reach from the northernmost point in North America to the southernmost in South America.

Our 1942 production goals also require us to send Britain a half billion dozen eggs, some 18,000,000 pounds of canned poultry, enough fresh fruit to fill 750 miles of railway cars, and enough canned vegetables to fill 22

MEAT ANIMALS: TOTAL UNITED STATES SLAUGHTER, 1936-40 AVERAGE, INDICATED 1941, AND GOALS FOR 1942



Data on actual slaughter, but not including production goals

miles more. Now what relation do these quantities bear to our normal domestic production and consumption?

Much depends on how you look at it. Great Britain normally produces only about 37 percent of her own food, and her food consumption as a whole dropped below normal during the 1940–41 winter. To balance her national diet she would need from us one half our normal output of cheese, one and one half times our normal production of evaporated milk, and five times our normal production of dried eggs. Yet such quantities do not bulk so very large when compared with our total agricultural production

For example, while wheat production is to be reduced 15 percent under the 1942 goals, lamb and mutton production will have to be increased only 2 percent, milk 7, eggs 10, chickens 13, pork and lard 12, and the quantity of beef and veal marketed 10 percent If we use 100 as the index of farm production for the 1924–29 period, the average for 1936-40 was 105, the 1941 index will run about 113, and the 1942 production goal only 115. So we simply need an over-all increase of 2 percent in farm production to achieve the goals

Britain will take only 6 to 8 percent of our output of the particular farm commodities she requires of us.

Take milk as an example. During the latter 1930's we produced about 106 billion pounds a year. In 1940 we had an all-time high in farm production and the output was 111 billion pounds of milk. The 1941 output is expected to top that by being 117 billion pounds The goal for 1942 is only 125 billion pounds, of which 5 billion will go to Britain and 3 will remain here to improve the American diet.

But if all Americans had a "best adapted diet," this country would utilize 20 percent more milk and 15 percent more butter. We should use fluid milk at a rate of 295 quarts a head a year instead of 168 quarts as at present. Incidentally, we should also use 70 percent more tomatoes and citrus fruits, 100 percent more leafy green and yellow vegetables, and 25 percent more eggs

Getting back to the milk can, though, this nation would use 140 billion pounds of milk annually, if all had "best adapted diets." Compare that with the 125-billion pound production goal for 1942 which includes Britain's 5 billion pounds.

Consider also what it would mean if we all got our full quota of the other foods mentioned above. It would mean an increase in our crop acreage equal to that used for export farm commodities in our best foreign-trade years. It would require a cultivated area equal to that in the State of Iowa—just to feed our own people

We shall step up our agricultural productive capacity to help lick the Nazis. We shall aid in feeding the nations which are fighting aggression But, at the very same time, we shall improve the nutritional status of our own people. When peace comes, we shall not destroy this productive capacity we have built. Instead, we shall let it run to full capacity and learn how to distribute the wealth it produces equitably to all who need it.

Corn into hogs, hogs into food, food into victory

Secretary Wickard, a dirt farmer himself, with a profound feeling for the underfed underdogs, is determined that all citizens of the United States shall be guaranteed a full basic diet after the war. Secretary Morgenthau has echoed this by saying: "My own feeling is that we should guarantee to every man, woman, and child the right to have enough milk and butter, enough fruits and vegetables, enough of the protective foods of all kinds so that every one can be fit to do his part in the world of tomorrow."

They thrive on penny milk

This country is rich enough agriculturally to recognize every citizen's right to have a minimum standard of food upon which he can live the life of a free man Exactly that is what officials of the Department of Agriculture mean to see provided for all

A period of maladjustment, depression, and despair could follow this war. But post-war plans are already being formulated to prevent that. These plans include rural public works, reforestation, soil conservation, flood control, electrification, education, medical care, better market facilities, better housing, libraries, and also industrial decentralization, along with such extension and modification of the food-stamp and school-lunch plans as proves necessary to give every American his minimum basic diet These plans are of supreme importance as a bridge to a better way of life

Until recently, we Americans have displayed little ability to make equitable distribution of the vast wealth that science and technology have lavished upon us. Yet, considered as a functional or engineering problem, provision for the material needs of the common run of men offers no insuperable difficulty. We have the resources, the equipment, the techniques, the processes, the research laboratories, and the trained manpower.

Fundamental in post-war days will be experiments in and study of distribution. These, alone, can aid us in effecting the required readjustment of agricultural and industrial production, and in cushioning the social damage that might otherwise ensue. When adequately financed, they will maintain a floor beneath the physical health of our people and prevent the nation from repeating past mistakes. Ultimately, by making full provision for the basic needs of our own people, we shall greatly increase our national income and well-being.

That is what the food production goals for 1942 and food for Britain really mean.

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TRANSFUSIONS

Blood Types Now Quickly Determined

A new testing technique, employing the dried serum of rabbit's blood, will be used by army surgeons to classify soldiers' blood into one of the four known groups quickly, safely, and cheaply, according to Lederle Laboratories, Inc., who developed the new method. The rabbit serum is used only for testing purposes and not for transfusions. Thus invaluable time will be saved in giving blood transfusions, when needed, to soldiers in the United States Army because each man's identification tag will now be stamped to designate his blood group determined by army surgeons in advance. With this information always available, the selection of the man to give blood safely to another can be made immediately.

Transfusions can be given safely only after tests have shown that the blood of the donor will safely mix with that of the recipient, and only human blood can be used. If blood of the wrong type should be given the patient, clumping of the donor's cells would occur in the body of the recipient, causing a shock reaction and possibly death. The necessary tests, made by the old method with the serum of human blood, were time-consuming when minutes might mean the difference between life and death for the patient.

The new testing technique employs dried serum from the blood of rabbits which have been previously injected with human blood corpuscles of known groups. This treatment increases the potency of the rabbit's blood in the substances which differentiate the several groups of human blood. The corpuscles are separated from blood drawn from the treated rabbits, the clear serum is treated to remove non-specific substances and then reduced to a powder by careful drying. In the dry, powdered form, the serum retains its value for test purposes indefinitely.

Two types of dried rabbit serum are necessary for the typing of human blood. In making the test a single drop of the unknown blood drawn from a person is diluted with a small amount (about eight drops) of normal salt solution and two drops of the blood solution are placed separately on a clean slip of glass. To one drop is added the tiny amount of Anti-A powdered serum that can be picked up on the end of a tooth pick. Anti-B serum is similarly added to the other drop. At the end of half a minute, the two drops are examined with the naked eye or a hand lens. If no clumping of the blood occurs in either drop, the blood is Group O. If clumping occurs in both drops, the blood is Group A-B. If clumping occurs with one and not the other, the blood belongs to Group A or B according to which kind of dried serum causes the visible clumping.

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SENSITIVE—Light so feeble that it cannot be measured by the most delicate optical instruments can be perceived readily by the human eye, experiments conducted at Columbia University show. The human eye, it was found, can perceive light if it falls on as few as five molecules of the receiving substance of the retina.

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GRAY HAIR

Darkened by Doses of Vitamin B

"A marked darkening" of previously gray hair and growth of "new natural colored hairs" in 30 human beings has been achieved by small daily doses of one of the newest of the vitamin-B group, para-aminobenzoic acid, according to Dr. Gustav J. Martin, of the Warner Institute for Therapeutic Research, and S. Ansbacher, of the research laboratory of the International Vitamin Corporation, states *Science Service.*

This is the first report before a scientific society of the "cure" of gray hair in humans by this vitamin, although there have been a number of reports of the darkening of gray hair in rats and mice with doses of both para-aminobenzoic acid and other B vitamins.

Like the other B vitamins, the para-aminobenzoic acid is found in yeast and liver. For the treatment of gray-haired humans the synthetic vitamin, which costs about ten cents a pound, was used. The daily dose is 100 milligrams (about two-hundredths of an ounce). But Dr. Martin warned that it should be taken only under a physician's direction because this chemical has other effects, some of which are only just being discovered. It counteracts the curative effect of the sulfa drugs, for example, and under certain conditions might raise the blood pressure.

MIND AND BODY

Does Mental Receptivity Control the Physical?

An amazing story of how a childless couple were finally able to have a child of their own after they had decided to adopt a baby has been told in *Psychosomatic Medicine* by Dr. Douglas W. Orr, Menninger Clinic, Topeka, Kansas. Not infrequently a childless wife becomes pregnant some time after adopting a child. Some psychologists believe the supposed "sterility" was really caused by an unconscious opposition to childbearing. This opposition disappears with the adoption and rearing of a child. Deep psychological barriers are lowered, and the machinery of pregnancy is enabled to function.

Dr. Orr's case was somewhat different. The wife's apparent previous inability to bear a child was traced by psychoanalysis to her own childhood. Her father had wanted a boy. To grant this wish as far as possible, the mother brought her daughter up to be tomboy. She was made to wear tailored clothes, her boyish figure was praised, and she was encouraged to express her athletic abilities by playing golf with her father.

Because of this, Dr. Orr continues, the young girl came to believe "she could not have a child because she was not enough like a woman, and she had no confidence that she could care for a child if she were to have one."

This state of mind carried over into married life because her husband encouraged her to work. To her this meant, "you must go on being like a man." This belief that she was too masculine, the psychoanalysis indicated, prevented her from becoming pregnant.

However, when husband and wife decided to adopt a child, she was encouraged by her husband to stop work. Her resignation, Dr. Orr concludes, "enabled her better than ever before to turn toward and accept her basic femininity." Shortly after her resignation and adoption of the child, the wife became pregnant.—*Science Service.*

Our Navy's Air Arm

Flying Sailors of the United States Have Long Been Regarded as Best Trained in the World

JAMES L. H. PECK

OUR Navy is at war. Its operations in both the Pacific and Atlantic involve two principle strategic missions. the ability to obtain enemy information quickly and with reasonable security; the firepower and flexibility to strike at these Axis sea forces once their intentions become apparent. This applies equally to cruisers, submarines, or aircraft—or the Navy as a whole—but the aircraft, because of their speed and range, are particularly suited to carry out these tasks No matter how formidable sea power may be on the surface, it requires the support of aviation to gain a decision against an enemy's sea-air combination Deprived of such support, surface vessels cannot operate with the necessary freedom of action.

This is not news to the United States Navy. In February, 1913, Lieutenant John H. Towers—now Rear Admiral and head of the Bureau of Aeronautics, Navy Department—performed the fleet's first patrol flight and "discovered" the enemy at sea. Even before this flight was accomplished, Towers and Glenn Curtiss—who had taught the former to fly in 1911—envisioned a long-range flying boat. The Curtiss planes of the famous NC type were the first of such craft to be built, the forerunners of our crack "VPB" patrol planes. In November, 1918, one carried aloft 51 persons in a test flight. That was news in those days. In the Spring of the following year, another flying boat, the NC-4, completed the first transatlantic flight; which was also big news. Today, our patrol bombers are capable of speedy non-stop crossings in routine operations. Three of the newer types can make it a round trip or remain awing for a couple of days at a time

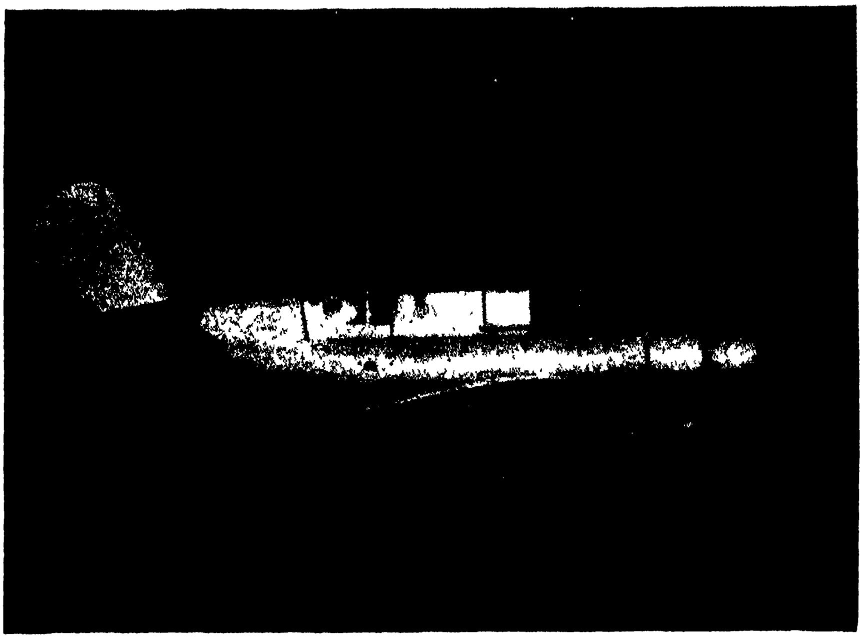
Not so farsighted are the eyes of the "VSO" aircraft which are carried to sea aboard battleships and cruisers and launched from catapults for scouting purposes. These seaplanes, however, are highly essential for a number of reasons which will be examined later. In November, 1915, Lieutenant-Commander H. C. Mustin made the first catapult launching of an aircraft from the U.S.S. *North Carolina.* Although this artificial take-off was the first to be made from a vessel, Lieutenant T. G. Ellyson—along with Towers and Lieutenant John Rodgers, one of the three original Navy aviators—had piloted a flying boat three years prior to this from a catapult built on a small dock at the Washington, D. C., Navy Yard. Present-day scout-observation craft take wings from our battleships and cruisers by means of 70-foot catapults motivated by compressed air

All illustrations Official Photographs, U S. Navy
Advanced trainers — obsolete service planes

Just as America pioneered in these means of finding an enemy at sea, so did we conceive and develop methods for carrying out the second tactical purpose in naval warfare; that of striking with flexibility and heavy firepower. There is the dive bomber. We made it first. Germany made it famous. We make it best. The Martin BM-1, closely followed by the Curtiss O2C-1 *Helldiver*, both of which were of 1926-27 vintage, were the first dive bombers as such to take to the air anywhere. Both the planes and the tactics in which they are employed have undergone continual refinement in the interim. Although the Nazi *stukas* made the world dive-bomber-conscious during the Spanish, Polish, and Low Countries campaigns, the Navy's four new types are now far superior to any in the world in speed, warload, range, and armament.

Then there is the torpedo plane which is doing yeoman duty in the war at sea. It is, perhaps, the flying fleet's most potent striking force. Although the British Admiralty used several types of planes for carrying torpedos before and during World War I, and they launched the first successful attack against a surface vessel late in 1915 in the Sea of Marmara, the development of the torpedo plane to its present tactical efficiency is the handiwork of the United States Navy. Until the carriers *Lexington* and *Saratoga* entered service early in 1928, the torpedo bombers were fitted with twin pontoons: since that time, they have operated from the carrier decks as wheeled landplanes.

THE aircraft carriers, great floating airports on which much of the flying fleet roosts, are last, but far from least, among America's contributions to naval science. The carrier, also, is not too new an idea. Eugene Ely, Curtiss test pilot and the original member of that now highly specialized profession, in November, 1910, made a flight from a platform built on the bow of the U.S.S. *Birmingham* at Hampton Roads, Virginia. In January of the following year, Ely landed his plane upon a large platform built over the stern of the U.S.S *Pennsylvania* anchored in San Francisco Bay. These were sensational flights, and were considered in the light of stunts rather than as practical demonstrations. After landing on the *Pennsylvania*, Ely took off from the same platform and returned to his base ashore. The aircraft carrier had been born. Authority was given the Naval Aeronautical Service, as it was then called, in October, 1919, to convert the collier *Jupiter* into a carrier, and this ship was renamed the *Langley*. Three years later, to the very month, the first landing upon a carrier deck was accomplished by Lieutenant-Commander G. deC Chevalier. A few minutes later, Lieutenant-Commander V C Griffin lifted the plane from the *Langley's* deck in the first take-off from a carrier. Seven of these floating air fields are now in the commission of the United States Navy, and eleven more



Helldiver, best and fastest dive bomber; better one is under experiment

are now in the course of construction.

Navy ingenuity is not confined to these larger items; any number of important devices and much aircraft material were conceived and developed by the Bureau of Aeronautics Included is the carrier arresting gear, very secret and said to be finest in use anywhere; flotation gear to keep both plane and pilot afloat after emergency landings, the Sperry bombing sight, which gained fame in Army hands, but which was originally built to Navy specifications; a vital process for corrosion-proofing of aircraft metals, and many important gadgets and instruments which are the brain children of the design and engineering divisions of the Naval Aircraft Factory.

When the fleet goes to sea, the air force—with the exception of occasional bombing operations—remains a component of the fleet; just as much so as the battle force, cruiser force, or the scouting force. Despite its tactical importance, the air arm is but a part of the overall naval picture

Let's take a look at this picture. The fleet is far at sea in cruising formation ships are strung out over miles of tossing, angry ocean, one vessel barely within sight of the other. The maneuvers are worked out aboard the flagship on the admiral's chart.

Curtiss *Seagulls* (SO3C-1's) and Vought-Sikorsky *Kingfishers* (OS2U-2's) are shot from the catapults of the dreadnaughts and cruisers. These scout-observation planes sweep ahead of the fleet to spy out the movements of enemy vessels. They are joined by Brewster *Buccaneers* (SB2A-1's), Curtiss *Helldivers* (SB2C-1's), Douglas *Dauntless* (SBD-3's), and Vought-Sikorsky *Vindicators* (SB2U-2's) from the carriers. These latter four types of craft will stop scouting and commence bombing when the enemy is sighted, they are designated as VSB scout bombers but go into action as dive bombers, which they are insofar as design and armament is concerned Radio contact reports from the other observation planes to the flagship greatly facilitate the "chart maneuvers" by keeping the admiral and his officers informed of the goings on. When the engagement starts, these scouts will also maintain contact with the "spotters" and "plotting rooms" of their respective ships to aid in range correction, thereby defeating the purpose of the enemy's smoke screens, which are intended to conceal vessel movements and formations.

Meanwhile, the carriers' other planes are taking off. Crack fighters streak off to engage those of the enemy Big, fast torpedo bombers such as the Douglas *Devastators* (TBD-1's) and Grumman *Avengers* (TBF-1's) roar away to strike at the hostile main body. These craft carry either torpedos or large bomb loads, depending upon the circumstances. Higher up in the now smoky sky are the "big boats," the patrol bombers that have come forth from distant mainland or insular bases These include the giant Consolidated *Coronados* (PB2Y-2's), *Catalinas* (PBY-5's), and Martin *Mariners* (PBM-1's and PBM-2's).

The Naval Air Service's position of pre-eminence is due largely to this sparkling array of aircraft, many of which have proved themselves nobly in service with Britain's fighting Fleet Air Arm. Brewster and Grumman fighters have bested the vaunted Nazi Messerschmitts on many occasions, as well as the best craft Italy can put into the air. The *Catalina* boats have done yeoman duty in the Mediterranean, and it was one of these ships—with an American observer aboard—that spotted the *Bismark* after 1941's greatest sea hunt. The Grumman F5F-1 and Vought-Sikorsky F4U-1 are among the world's six fastest fighters; and none of the other four are naval craft carrying the many extras demanded by over-seas operations The naval expansion program calls for thousands of these crafts, the total to include the highly essential trainers and utility airplanes The largest naval air arm in the world for several years, our flying fleet is rapidly growing even stronger wings.

This speedy growth necessitated the immediate training of thousands of pilots, navigators, bombardiers, gunners, flight mechanics, and ground personnel. Like the planes they fly, our naval airmen have long been regarded as the best trained anywhere in the world, and this is the result of the philosophy of "naval aviators for naval aviation"; these young men are flying sailors rather than sea-going fliers. The time spent in learning about things nautical and becoming accustomed to maritime practice pays big dividends Without this specialized training, the fliers would be unable to identify types of warships, or distinguish between theirs and those of the enemy; they would be unable to interpret certain tactical maneuvers they might observe from above or to carry out numerous other duties requiring sea training, such as scouting and search problems.

The Naval Air Stations at Pensacola and Jacksonville, Florida, and Corpus Christi, Texas, are bearing the brunt of the training of the new pilots called for by the expansion plans. The flying cadets enter one of these three schools with the rank of seaman, second-class, after they successfully complete a 30-day preliminary course at one of the several Naval Reserve Aviation bases throughout the country. Advanced training for carrier flying is conducted at the Miami Naval Air Station for graduates of the three larger schools who are to specialize in this type of work. The regular one-year courses at Pensacola, Jacksonville, and Corpus Christi have been cut to seven months duration in order to step up the training program, but the change does not result in a reduction of flying time

The embryo aviators still receive about 225 hours of flight instruction, and are better equipped to fly one particular type of plane than they were under the full-year training scheme. This has been made possible through specialization· If the cadet is chosen for fighter duty, he begins his training in landplanes and, upon completion of his advanced work, flies older fighter types. Cadets chosen for other carrier branches—scouting, dive bombing, torpedo bombing—follow a similar course. Only the selectees for battleship and cruiser seaplane duty and those for patrol work receive seaplane training; formerly, all Navy pilots flew seaplane trainers during the primary phase of their instruction. Upon completion of the courses, the cadets receive their hard-earned gold wings and Ensign's commission. Post-grad work, a sort of aerial internship, involves further training and seasoning with tactical squadrons of the Fleet.

Back of the pilot training program are crew members, mechanics, and additional ground personnel who "keep 'em flying" Enlisted men enter the many Navy trade schools to receive one-year apprentice courses, after which they go to naval station overhaul bases for further training Officers are afforded special courses at the Naval Academy and certain colleges and universities that have to do with aeronautical engineering, naval architecture, and meteorology. When the flying fleet is at work a thousand or two miles from the nearest base, this Navy personnel must make repairs and perform the necessary engine, aircraft, and accessory checks without the help of the specialists normally available at a large base An operational unit carries with it engine and aircraft mechanics, metal workers, carpenters, radio technicians, armorers, and so forth. The squadron engineering officer—who is usually a graduate aero engineer as well as an experienced naval pilot—must know not only operating maintenance but also the practices and methods of repair maintenance. Each of the carriers and seaplane tenders has extensive shops and laboratories available for this overhaul work.

Gunners, also, are usually mechanics, and these men are trained at the San Diego and Norfolk air stations Bombardiers and navigators are trained at the Miami school.

The Naval Air Service must have bases from which to operate. The expansion has already increased stations and airdromes from the seven shore establishments in 1939 to more than 30 major bases, and, in addition, several auxiliary bases. All the new stations and bases in the Western Hemisphere will be in operation by the time this is in print: these extend from Iceland and Greenland down to Georgetown, British Guiana; from Alaska down to Honolulu.

Before this war is over, the Navy will undoubtedly have an opportunity to prove that its planes, the men who fly them, and the tactics in which both are employed have no equal in the world Secretary of Navy Knox phrases it best in his own words:

"Since the invention of the airplane, our Navy has used more aviation than any other major power, has put aviation to more uses in co-ordinated combat, including bombing and observation. It is a tribute to the officers and men who run our Navy that the lesson of sea-air power in World War II bore out a theory they had already put into practice"

Large Navy flying battleships have high-speed, long cruising range

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WATER 'CHUTING

Marines Use Gas Inflated Jackets

An interesting and additional note on the training of Marine parachute troopers, supplementing the detailed description published in our January issue, has to do with water jumps When United States' sea soldiers are forced to "have the situation well in hand" by an attack from plane carriers, provision is made for landing the parachutists in the water.

For this work the Marines are equipped with inflatable rubber jackets under their 'chute harnesses. As the parachutist approaches the water, he slips out of his harness while still 10 or 15 feet above the sea and drops into the water. Freed of the weight, the 'chute drifts away so that as the Marine rises to the surface after plummeting into the sea he is not likely to be smothered by having the silken canopy land directly above him. Meanwhile, the Leatherneck paratrooper must remember to release the toggle on a small, metallic cartridge—much like the one used in a charged water bottle—which is attached to the mouth of his deflated life preserver The cartridge is charged with carbon dioxide and blows up the rubber jacket, helping the 'chutist to rise to the surface, and to remain there.—*A. D. R., IV.*

FLUORESCENT

Fabrics for Use in Blackouts

Workers in factories and pedestrians in traffic can be made visible during blackouts by fluorescent-dyed clothing and ultra-violet lighting. Clothing dyed with fluorescent colors glows in invisible ultra-violet light—permissible in blackouts—with a subdued radiance bright enough to be seen nearby but too weak to be visible at a distance, even in a blackout otherwise complete. In blacked-out plants equipped with ultra-violet lamps, workers wearing such garments are readily visible to their associates

Traffic control during blackouts can be effected by using ultra-violet lamps in traffic lights and in the headlights of vehicles. In the invisible radiance from these lamps, clothing dyed with fluorescent colors glows brightly enough to make persons wearing it visible to drivers or other pedestrians but not to aviators at a distance.

Dyes of many shades, possessing fluorescent properties, are available for

Left: **Fluorescent-dyed clothing in light and,** ***right,*** **in the darkness**

application to various textile fibers and fabrics, according to officials of the Calco Chemical Division of American Cyanamid Company. In ultra-violet light, they give fluorescent colors varying from violet through blues, greens, yellows, oranges, and browns to rich reds.

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AIR CONDITIONING—In protecting power and equipment, in speeding the production of thousands of articles of defense machinery back of the lines, and generally in helping men and machines to work better, air conditioning is month by month increasing its service to the all-out war efforts of the nation.

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OVERPASS

For Speeding-Up Cross Traffic

Briefly referred to in the article on the army engineers, "Builders For the Army," published in our issue of December 1941, was "a portable overpass invaluable when one column of troops must cross another's line of march." Such a portable overpass has also been developed by R G. LeTourneau, Inc., which not only has military implications but also can be brought into service during especially heavy traffic periods or can be left permanently in one location for civilian use.

The portable overpass, shown in one of our photographs, consists of three 60-foot sections with detachable legs having adjustable piers to fit any site contour and provide the required clearance for under-crossing traffic. Rigidly built of alloy steels, arc-welded throughout, the overpass incorporates box-beam side girders and floor joists and a solid steel floor plate. It is claimed that it can be assembled and ready for use in as short a time as two and one-half hours. When the overpass is to be moved to another location it can be carried by a two-ton truck-trailer outfit or on railroad flat cars.

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RESPIRATORS—The Chemical Warfare Service of the United States has recently received delivery of 100,000 respirators which weigh only one and a half ounces and yet will exclude dust particles as small as 1/25,000 inch in diameter.

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CURTAINS

For Blackouts: of Wool, Paper

"Blackout" requirements at present are puzzling many people in all sections of the country Due to the heavy demand for appropriate material for such use, shortages have occurred in some localities. The Felt Association, Inc., stated recently that it had been noted that many people do not realize the adaptability and advantages of wool felt, an available commodity, for blackout curtains. Ordinary light will not penetrate felt of suitable grade, and it may be readily used for window shields for office buildings, power houses, water works, and other types for factories and defense plants working night shifts. For windows in homes, felt is practical, as it can be tacked, glued, or pasted in almost any form without tearing, and can be cut to shape without ravelling. It also may be attached to shade curtain rollers, replacing the usual shade cloth. Colors—brown, green, navy and dark blue and olive drab—are just as satisfactory for the purpose as black, and of course are more desirable from the interior decorator's standpoint. Felt may be flameproofed and mothproofed.

Another material that has been proved satisfactory for "blackout" use in the home and factory is Sisalkraft. This sheeting has been war tested in England since 1939 and it is still being used today. It has been approved by the Air Ministry, Admiralty, War Office, H. M Office of Works, Ministry of Home Security, and other departments of the English Government.

One reason that Sisalkraft is effective for blackout purposes is that it is composed of two sheets of kraft paper cemented together with two layers of asphalt and reinforced with sisal fibers. This composition makes Sisalkraft opague, strong, pliable, and, above all, highly reflective, so that a factory using this material as a blackout does not need any additional power for lighting, whereas black cloth absorbs light and painting prohibits the use of daylight Sisalkraft can be used as a screen on wood frames, made to fit the window opening tightly, or as a roll curtain. In England they have found that a 9-inch overlap on the sides of the windows is essential when used as a curtain Sisalkraft reflects approximately 70 percent of the light that impinges on it, and, furthermore, the material can be rolled up or removed during the day, thus permitting the use of natural light.

Expedites traffic movements, both military and civilian

Rolling Off a Log

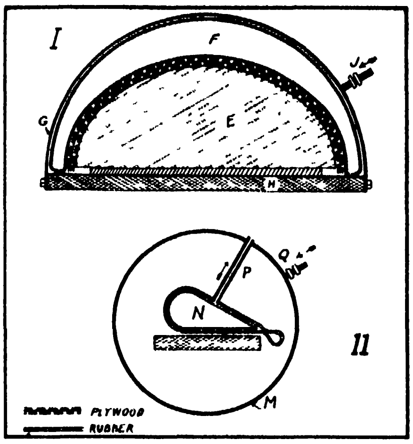
Plywood Made Available for Many New Applications by Development of Synthetic Adhesives

THOMAS D. PERRY

Plywood, which consists essentially of layers of veneer bonded together with adhesive, is an ancient material that in very recent years has been freed from former limitations to an extent making it of pronounced value to defense activities as well as to normal peacetime uses. Limitations on the use of plywood have always been those of the available bonding agents and the technique of using them. Until the practical development of synthetic resin adhesives during the last ten years, many fields of possible application were barred to plywood by the inferior durability of conventional glues. Now, with dependable bonding agents, plywood not only is meeting what might be termed its logical uses but is being put to work in unexpected fields, where it can satisfactorily take the place of less generously available materials, such as the lighter metals.

The rudiments of modern plywood construction—that is, with the grain of alternate layers at right angles—were first recognized between 1830 and 1840, in piano pin planks made of sawed veneer. The purpose of the cross layers was to insure a firm grip of the wood fibers on the shank of the tuning pin, so that after many years of twisting, the grip would still be firm and no signs of splitting would be manifest in the wood.

The making of cross-laid veneer products began to emerge as an industry early in the 1880's but grew rather slowly until about the beginning of World War I. The unusual ratios of strength to weight in plywood attracted the attention of the early aircraft engineers, who used plywood extensively in the primitive aircraft of that time. One of the handicaps to the new industry was the terms "veneer," "veneered," and "veneering," which suffered from somewhat sinister dictionary definitions. Manufacturers, trade associations, and government agencies joined in the search for a better name. The author well remembers the earnest discussions of those days, resulting in the choice of the term "plywood," which has since become the standard description of basic veneer assemblies. It had been an obscure technical term, little used and less understood, but has come to carry its new responsibility most efficiently. Plywood is a product made of veneer, as shoes are made of leather, as machines are constructed of iron and steel, as houses are built of wood and masonry, and as cloth is woven from thread and yarn.



Courtesy Institute of Aeronautical Science

All-directional pressure for bonding plywood structures, as in forming half-fuselages, is secured by the flexible-bag method. I: Bag F is inflated through J and restrained by shell G, attached to base H. Mold E (metal or wood) is recessed for frame members; veneers thus are bonded into plywood and plywood is attached to frame in one pressure application. II: Bag encloses aileron N, temporarily fastened together. Bag is deflated through P, which remains as a vent. Tank M is filled through Q, imposing external pressure through the bag on the aileron, fabricated of plywood

Serviceable plywood requires a suitable quality of veneer and a dependable adhesive. The older conventional glues—animal, casein, vegetable, and soybean—had their good qualities and would render acceptable service under ordinary conditions. When subjected to severe heat, moisture, and exposure to weather, however, none of them would withstand prolonged service, and, as a result, the use of plywood was restricted to moderately protected locations. Plywood made with the old glues was, of course, often blamed for failures that were caused by unintelligent adaptations.

During World War I, both cold-pressed casein and hot-pressed blood albumin were used in airplane construction, as they were then the best-known water-resistant glues. Both were of limited durability, were attacked by molds and fungi, and would deteriorate under severe exposure. The inadequacy of these glues, coupled with the vigorous promotional efforts of the rapidly developing aluminum industry, more or less sidetracked the use of plywood for aircraft. As a consequence, the airplanes of the succeeding 20 years were largely made of the lighter metals.

In the early 1930's resin adhesives were little more than interesting laboratory experiments, but of definite promise if their cost could be reduced. Around 1935 a phenol formaldehyde resin film, from domestic sources, became available at reasonable cost. It required curing, or hardening, under simultaneous heat and pressure, and the bond was irreversible; that is, it would not weaken or deteriorate from heat, moisture, or fungus. In durability, the bond would outlast the wood itself. It was soon recognized to be an adhesive with such service characteristics as to make plywood fully available for aircraft and boats. Supplementary to this resin film were a number of other resin adhesives, both urea and phenolic, with similar service qualities. The ureas were not quite so durable as the phenolics but could be cured even at room temperatures The phenolics, which equaled the first film in durability, became available in liquid and dry forms for a wider range of applications

Veneer is the raw material, direct from the tree or log, from which plywood is assembled with a suitable adhesive. Over 90 percent of the veneer used is rotary-cut on a lathe, much as paper is unrolled Sliced veneer is cut similarly from the flat side of a log segment, but can be no wider than the log. The cutting of rotary veneer gives much higher log yields than does sawing into lumber. Veneer is used, of course, for many products other than plywood, such as fruit and vegetable containers, hand baggage, and so on

Since wood is strong lengthwise and weak widthwise, the crisscross structure of plywood, offsetting this widthwise weakness, imparts to the material

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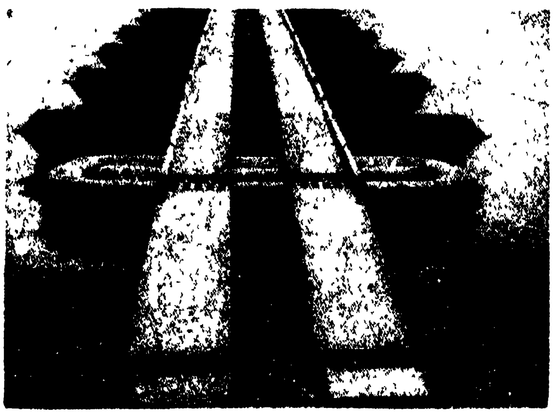
Courtesy *Technology Review*, from which the present text was slightly condensed. The author is Sales and Development Engineer of the Resinous Products and Chemical Company and author of a book entitled "Modern Plywood."

substantially equal strengths in both directions. The original strength of the wood is reinforced by the adhesive, so that the aggregate strength of the integrated plywood is greater than the total strength of the veneers composing it. Plywood in its simplest form, three-ply, has two outer layers with parallel grain, each half the thickness of the center layer, or core, which has its grain at 90 degrees to that of the faces The result is what is called a balanced construction.


Courtesy Plyweld

One application of the ultimate product of the process of rolling off a log. This experimental plywood ramp, developed by the United States Army, will carry large loads. The individual sections are quickly joined at their finger-like ends with pins and are easily transported by Army trucks to the point of use

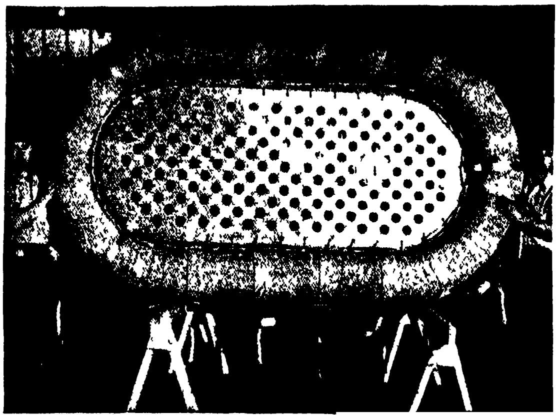
Another common construction is five-ply, in which the strength of the wood fiber may be equalized in each direction, or in which a thick lumber core may be used to give a dominant strength in the direction required. In the standard five-ply type, the cross layers between the core and faces are called "crossbands" Crossbands of 1/16 inch will give adequate stability to plywood one inch thick.

Multi-ply constructions, seven, nine, eleven, thirteen, and so on, are often used when strength distribution and durability factors are important, as in aircraft and boats. An even number of plies is seldom used, as it results in an unbalanced construction and tends to cause warping and twisting. An exception is two-ply, which is often made for curved work, where the reinforcing of the double layer reduces the hazard of rupture of the veneer during bending. Two-ply is seldom an ultimate product but is, rather, an intermediate step toward the manufacture of a higher ply.

Laminated wood, a term used to describe a veneer construction in which all layers are parallel, is usually made in plywood factories. Its purpose is to maintain lengthwise strength and stiffness, which are sacrificed in standard plywood constructions. In fact, laminated wood is stronger than normal solid wood of the same dimensions, because of the overlapping of the slightly angling wood grain.

Generally, the thinner the veneer layers, the stronger the plywood or laminated wood. Veneer can be cut as thin as 1/100 inch, but economic considerations prevent the extensive use of veneer thinner than 1/40 inch.

The applications of plywood rely upon qualities peculiar to the material, which may be summarized thus: The strength of plywood may be distributed equally in both directions, whereas normal wood has a predominant strength in one direction only. Plywood cannot be split, because of the holding power of its adjacent layers. The shrinking and swelling of plywood, under exposure to moisture, are relatively slight. Wood does not shrink appreciably endwise, and the widthwise veneer is held to stable dimensions by the immediately adjacent endwise layers. This factor reduces warping far below that of normal solid wood. After gluing, plywood can be bent and curved to a much greater extent than normal wood, because of the reinforcing effect of the neighboring layers. The limber veneer layers can also be bent during bonding, when they easily slip by each other but are sturdily held in the curved position by the adhesive. The strength-to-weight ratios of plywood are exceptionally good, especially for aircraft and watercraft.


Courtesy Bristol Aircraft Corporation

Laminated lumber and plywood in a life raft. The ring is made of balsa wood, resin bonded, doweled, and tightly wound with canvas strips. The floor is perforated plywood. Ten by five and a half feet, the raft accommodates 25

Consideration has so far been given to normal plywood, in which wood compression is nominal and only enough to bring the veneer surfaces into close contact. If greater pressures (500 to 1500 pounds and even higher) are exerted, the veneer is compressed into a high-density plywood with a larger amount of wood fiber per square inch of cross section and a proportionately greater increase in strength. If the veneer layers were originally 1/30 inch thick and are compressed to 1/45 inch with a resin adhesive between them, a substantial amount of resin impregnation occurs. A 50 percent increase in material will double both tensile and shear strengths.

Several types of high-density plywood are made, depending on the ratio of wood fiber to resin, on the pressure exerted, and on the kind of resin used. A phenolic resin film can be employed to give a product which is essentially wood reinforced with resin, with wood characteristics predominating. The film process is simple, and the amount of resin can be controlled by the thickness of the veneer layers.

Another method for high-density work, which produces what is referred to as "impregnated wood," forces liquid phenolic resin into the voids of the wood fiber, and then, after reducing the solvent content by predrying to avoid blisters in hot-pressing, compresses the whole in a hot-press, as with the resin film. The result is a resin reinforced with wood fiber, in which resin characteristics dominate. The resin content is considerably higher (of the order of 30 to 10) than in the film product, and water absorptive capacity is less. Both products are affected far less by moisture than is normal wood or plywood.

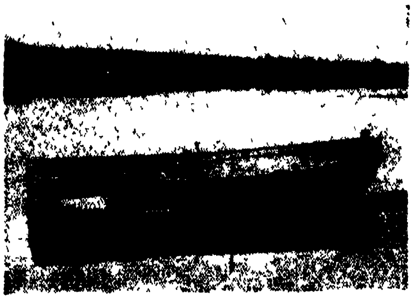
An interesting development of high-density plywood is that of variable-density construction. Here more layers of veneer are used at one end than at the other and the whole assembly is compressed to an even thickness, resulting in greater compression and higher density at one end.

The ability to predetermine density and strength gives to designers of plywood structures a facility that exists with few basic materials. While this procedure can be compared with the alloying and heat-treatment of metals, it has an even wider application range.

Plywood lends itself efficiently to forming and shaping Attachment or connector clips made of plywood are easily bent and bonded between pairs of heated metal dies. These clips and braces can be made of normal or high-density plywood, depending on strength requirements. The use of them, with adhesives, in constructions involving plywood-to-plywood or plywood-to-frame members, reveals one of the marked advantages of plywood over the metals. Riveting, spot welding, or strip welding must be employed with metals, whereas the clips or braces used with plywood can be glued over their entire area and supplemented, if necessary, with mechanical fasteners to maintain pressure until the adhesive gets its initial grip. Rivets are costly, the installation of them is time-consuming, and the irregularities of the resulting surface are most unfavorable in air or water currents. Glued plywood provides the smooth streamline surface, strongly attached to its framework, which is so essential in aircraft and boats. This forming and shaping can be done best in heated dies, using thermosetting resin adhesives.

One of the newer techniques in the plywood industry, although it has been used in rubber vulcanizing for years, is the flexible-bag method of applying pressure. A distinct advantage of this process is its quality of fluid, or all-directional pressure—in other words, the pressure is perpendicular to all flat or curved surfaces within its range This fluid pressure can be exerted in a number of ways and the fluid-pressure medium can be air, steam, hot water, or a combination of them, the chief problem being rapid application.

The assemblies on which the technique is usable can be of veneer or of two-ply, of such widths and shapes as will make tight-fitting joints without overlapping In the half-fuselage shown in one of the drawings, the inner strips of veneer are longitudinal and tapered like barrel staves, the center layer is of moderately wide half hoops, and the outer layer is parallel to the inner layer. If a boat hull is to be made by this process, large two-ply sheets are customarily used, with V's, or gores, cut to permit proper curving or tapering of the layers. In an aileron, the skin covering may be made of either veneer or plywood, often laid at an angle of 45 degrees to the axis of curvature and temporarily attached to the inner framework until the adhesive acquires its grip. These are only two relatively simple constructions using resin adhesives of the phenolic type; many others employ combinations of these processes and apply flexible pressure in other ways.


Courtesy Plyweld

An experimental plywood towboat for the United States Army. It has an overpowered engine and marked qualities of maneuverability. Special rails for handling the boat in and out of the water are shown in illustration

The flexible-bag process permits making shell or monocoque constructions of an infinite variety of shapes and range of complexity. The method may be compared to the drawing of metals between pairs of dies, but it has the distinct advantage of resulting in a product that is more nearly free from internal stresses than is drawn metal It is also true that plywood can be molded into many complex shapes which are beyond the practical range of drawn metal.

Well demonstrated is the fact that resin adhesives have definitely greater durability when cured with heat than when cured with chemical reagents. For plywood constructions up to an inch in thickness, the surface application of adequate heat is entirely practical. For assemblies several inches thick, other methods of heat application are imperative The most satisfactory solution, so far, is to put the clamped plywood assembly in a high-frequency electric field of some five million alternations each second, provided by flat metal electrodes which are insulated from the metal parts of the press and are placed at the bottom and top of the assembly and within the press. The heat thus generated raises the temperature of the assembly within the field to the point necessary to polymerize the resins. The lines of resin adhesives are found to be some 20 degrees hotter than the adjacent wood, which is a favorable gradient that does not tend to dry the wood excessively. Other than this differential, the entire assembly in the field is heated instantly and the cure of the resin can be effective in a matter of minutes, depending on the intensity and capacity of the field.

Applications of plywood which are becoming increasingly important in the defense program are more readily visualized with these recent developments in perspective against the contrasting background of earlier limitations. Airplanes are one of the major products in which plywood can be of substantial importance in the present defense program. Perhaps the most obvious way in which plywood can serve the airplane builder is that of skin covering for the wings, tail parts, rudder, ailerons, stabilizers, and the like. Here the external streamlining of plywood, combined with its factor of stiffness to weight, gives it advantages over thin metals, which require riveting and welding and are less able to resist the aerodynamic forces without buckling and vibrating. The multitude of ribs and framing members required to support metal facings can be substantially reduced in constructions where several layers of plywood covering are superimposed for stiffness, all within permissible weights and strengths. Adequate resin adhesives are available for both the plywood bonding and the assembly operations. Plywood wings are now extensively used in military training ships.

Plywood fuselages, of molded monocoque shapes, have been made and flown successfully. Molded noses and nacelles, from plywood, are in actual production for several types of Canadian fighter planes. The chief drawbacks here are the lack of scientific strength-data and the formulas essential for efficient design.

Spruce spars are almost universal in smaller planes, yet solid spruce is scarce and costly. Laminated spruce is stronger than solid spruce, easier to obtain, far more uniform, with greater yield from the log. The chief problem in the use of spruce spars is that of attaching them to the fuselage and the landing gear; normal spruce has relatively low bolt-holding power. Solution of this problem is offered by high-density plywood with raised, or embossed knobs on one side. The knobs can be pressed (that is, drawn by bolts) into the lighter and softer spruce and firmly glued in addition. These high-density plywood attachment plates distribute the load transmitted from the landing gear, over as large an area of the spar as is necessary. Not only do they serve to reduce the use of metal but they can be made by woodworkers on woodworking machines, both of which are far more plentiful than the corresponding facilities in the metal field

Propellers need to be sturdy at the hub, where weight is not objectionable, and light in weight at the tip, where centrifugal forces are serious. Variable-density plywood meets these requirements and gives to the blade the resiliency of wood and the excellent fatigue characteristics of wood. Propellers so made are extensively used in England. These adaptations of plywood to airplane construction refer specifically to the smaller and lighter planes, including perhaps all types of training ships for military aviators. Experience must be gained in these smaller units, so that changes from metal to plywood in the larger planes may be based on actual demonstrations of serviceability under severe conditions. For the present, many non-stressed parts of the larger planes, such as bomb-bay doors, instrument boards, manhole and handhole rings, covers, doors, floors, and the like, may be safely made of plywood. An ingenious ribbed plywood floor, combining great stiffness with light weight, has recently been patented.

In large seagoing vessels, plywood has established a distinct place for itself in partitions and bulkheads. Crossbands and faces are glued to a lightweight asbestos core, providing fireproofness together with attractive and noncorrodible surfaces. Plywood can also be made with metal faces, or metal inner layers. Curved and rounded partitions can be made of plywood of still different constructions.

Many smaller vessels, such as destroyers, Coast Guard cutters, and the like, are designed with plywood bulkheads, dividing the boat into many compartments, for safety. Such bulkheads also serve as important strength members in the boat structure. They are lighter and more resistant to the elements than is metal, more free from shrink and swell than is solid wood, and far less prone to cracks and leaks. Plywood sheets up to 80 feet long by eight feet wide have been made for the hulls of such boats and are now in production. Several layers are used on the hull, with staggered joints. For the superstructures on such watercraft, streamline housings of molded plywood are beyond the experimental stage and may soon become standard.

The utility of plywood in boats increases as the size of the boat decreases. For boats 20 feet and under, thousands of hulls have been made by the flexible-bag molding process. Ribs and framework can be substantially reduced and often eliminated. Angling strips can be placed inside to serve as bracing members. Plywood for such boatwork is usually made in two-ply sheets, several layers being used to add up to a total thickness of ½ inch and more. These boats are far lighter and sturdier than those of the conventional construction, and the problems of shrinking and calking are practically eliminated.

Another interesting development is a pontoon molded from veneer and plywood. It weighs far less than sheet metal, so that fewer men can handle the units and truck-carrying capacity is multiplied several-fold. These pontoons are clamped together to support the runways of temporary pontoon bridges. The pontoons nest on the truck bed and require a height of less than one foot per unit. Ramps, or walkways, for use in pontoon bridges are also being made of plywood. Life rafts and towboats are other applications of the material.

Periodic rumors are heard that the supply of black-walnut lumber for gun-stocks is inadequate; in any event, the elapsed time from the green tree to the seasoned blank is unreasonably long. Plywood has been tested and found adequate, and is much more quickly available. Several species of veneer, pressed to the desired density, can be used.

When made of solid lumber, army lockers for soldiers' personal possessions are heavy and likely to develop unsightly and untidy cracks. With metal lockers, moreover, rust, corrosion, and denting become serious problems. Waterproof resin-bonded plywood hence has been used extensively in recent contracts.

Other uses of plywood, common to both civilian and military life, include concrete forms, prefabricated houses for defense workers and for military cantonments, furniture for living quarters and for offices, truck bodies, profiles for shipbuilding, patterns for foundry work, industrial buildings and equipment, partitions, and many other products.

Those who have studied the many problems involved in the intelligent use of plywood are becoming more keenly aware of the fact that it cannot be adequately evaluated and utilized according to the experience and knowledge gained from the use of metals. Wood and plywood have qualities and advantages that frequently are quite different from those of other materials. Certain tasks can be performed better by metal products, others by units made of veneer and plywood In no sense is one a substitute for the other The skilful combination of both materials will result in an effectiveness, a suitability, and an economy that cannot be secured by either alone.

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Duplicating Without Dies

Short-Run Production Requirements in Metal Shapes Met by Ingenious Hand-Operated Tools

A. P. PECK

A mid-western manufacturer had closed a contract for 400 medium tanks for the British government. Hence the plant would require 400 each of various types of eyes formed on arms and links for operating engine and turret controls. Also needed would be 400 each of specially shaped angle brackets for panel and dashboard mountings and a variety of other metal forms, each in multiples of 400.

Under ordinary circumstances these production requirements would be filled by means of a series of special forming dies, with consequent loss of time while the dies were being designed and made. Then, when the job was finished, most of the dies would probably be worthless for other purposes, after having been used for only 400 operations. Not only would the time element militate against the use of dies, but the cost would be out of proportion to the results.

Such production problems, not unusual under present-day circumstances, can often be solved by the use of a

Hand operated "production line"

Close-ups of the unit tools shown in the illustration on the opposite page. Top to bottom: The shear, the brake, and the bending device. To the left in the bottom picture are shown the two parts which are used for converting the unit for forming either right or left-hand radii with the side members turned out instead of in

series of hand-operated duplicating tools which turn out precision work for short metal runs and for experimental development projects. These tools, known by the name of Di-Acro, include a bench shear, a brake to produce non-stock-size channel and angle forms, and a bending unit which can produce a wide variety of curved and angle forms from any ductile metal, the range of contour bending being limited only by the expansion and contraction limits of the material being formed.

One of our photographs shows a shop "production line" using these hand tools. In the background one operator is shearing stock material to correct size. The worker in the center is using the brake to create the required angle in the sheared material, while the third operator is bending the angle members in right- and left-hand radii as called for by specifications. On the bench in the foreground are a variety of the shapes that can be produced by the bender through simple adjustments of the mechanism—adjustments that can be made by any ordinary apprentice-machinist and do not require the skill of a tool or die maker.

Since these tools are designed to produce duplicate shapes with the same accuracy as can be obtained with blanking or forming dies, it is obvious that the tools themselves must be of precise construction and provided with accurate stops that will make possible working within the ordinary tolerances of die accuracy.

The shear in the "production line" illustrated is designed to meet the requirements for a machine that will fit into industrial operations between the heavy floor-type foot-operated shear and the small thumb-and-finger "tinsmith" shear. By means of adjustable stops it can be set for die duplicating work, for trimming metal stampings, and for working stock size materials. The operator of the shear has close observation of his work at all times; the hand-operated lever provides a sensitive cutting control, yet the stability of the device makes possible accurate light shearing

The brake device fits into the industrial picture in the same manner as the shear—between the floor-type brake and the hand-operated vise and pinchers. Angle and channel forms can be produced in sizes from ⅛ inch upward and other types of folds can be accomplished to 110 degrees of radii.

The bending unit is a basic type of machine which will duplicate many varieties of metal pieces throughout a wide range of contour bending. The unit will receive without alteration to its design simple conversions for forming angle, channel, rod, round or square tube, round, square, half-round or flat wire and strip stock (flat or on edge).

As noted before, these units are designed for co-operative application to short metal runs, producing by hand an accurately duplicated run of pieces long before conventional blanking or forming dies could be completed for regular operation. Thus they can be applied either to a complete job, as in the case of the 400 tanks mentioned, or can be used as stop-gaps to fill in between the completion of a design and the completion of forming dies, where the ultimate aim is high-speed mass production. In such a case these hand-operated units will permit actual production to start much earlier than would otherwise be the case.

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TELEPHONE SAVINGS

Reclamation And Substitution For Conservation

A saving of more than 5,000,000 pounds of metals vital to defense needs including enough aluminum to build more than 275 fighter planes, or half as many bombers, was effected during 1941 by the Bell Telephone System through a materials substitution program.

In addition to such savings are the reclamation activities which the Bell System has been carrying on since 1931. At Tottenville, on Staten Island, New York, its reclamation unit, the Nassau Smelting and Refining Company, last year supplied the System with more than 42,000,000 pounds of metal, obtained chiefly from non-ferrous metals in outworn equipment, structures, and supplies junked by telephone companies. The amount thus junked in the course of a year totals upwards of 100,000,000 pounds, three-fourths of which is in metals.

How to make the most effective use of materials, particularly of new materials as they become available, has been under study by the Bell System since 1925. Immediately after the outbreak of the present war in 1939, a survey was made of critical materials used in making telephones and telephone equipment, and the determination of suitable substitutes was undertaken. With this advance preparation, the System is now able to make various substitutions in ways that interfere as little as possible with the continuation of first-class service.

The substitution program is made possible by long range planning, research by the Bell Telephone Laboratories, and readjustments in manufacturing by the Western Electric Company, manufacturing arm of the Bell System. These efforts diverted for defense use in 1941 nearly 1,700,000 pounds of aluminum, about a third of a million pounds of nickel, more than 3,000,000 pounds of zinc, and 8300 pounds of magnesium.

An example of substitution is the use of steel instead of aluminum in making the "finger wheels" in dial telephones. In this item alone the Western Electric Company is now saving about 65 tons of aluminum annually. The use of zinc is being materially reduced by coating much of the hardware used on telephone pole lines with lead instead of putting these products through a galvanizing process.

With the need to conserve rubber,

Western Electric planned to be using 20 percent less of this material by the end of 1941, chiefly by using more reclaimed rubber and careful use of materials having similar properties. For some materials research engineers have not yet found working substitutes. For instance, there is no known substitute for the zinc electrode in a dry cell. Other materials in telephone manufacture which are rapidly approaching the critical state are phenol plastic, phenol fiber, and silk.,

The telephone companies throughout the country have an important part in the effort to conserve materials. Their engineers point out that protection against raw material shortages is in normal times merely a matter of good "industrial housekeeping." But now such protection is vital to defense itself.

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STEEL—Over half a million tons of steel were bought in 1940 by American housewives through their purchases of refrigerators, kitchen ranges, and washing machines, the American Iron and Steel Institute has estimated.

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ALUMINUM CLAY

New Process Opens Vast Sources of Light Metal

A newly discovered process for the economical manufacture of aluminum from clay instead of bauxite was announced recently by Professor Arthur W. Hixson of the chemical engineering department of Columbia University. It is believed that the process may hold the key to United States independence of foreign sources of bauxite.

Developed at Columbia under the direction of Professor Hixson, assisted by Ralph Miller and Ivan J. Klein, the process consists of digesting selected high-silica clay with hydrochloric acid and decomposing the resultant product to obtain hydrochloric acid and aluminum oxide, or alumina The aluminum metal is then produced electrolytically in the conventional manner.

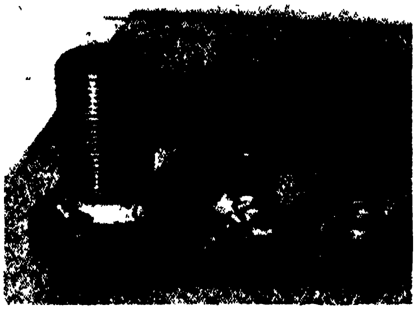
Quoting Dr. Hixson: "All present day processes for the production of aluminum utilize only high-grade ores, which consist of the mineral bauxite. The government's defense requirements for aluminum will soon exhaust the available supplies of bauxite in this country, with the result that the United States will soon depend entirely on imports for this important material.

"The economic feasibility of the new process results primarily from two things: First, the process utilizes a new technique never before employed in the metallurgical field. Secondly, it makes use of recently developed materials of construction and chemicals which are abundantly available because they are by-products of processes operated on very large scales."

BROKEN STUDS

Removed by Unique Use of Welding

A knotty problem often encountered by mechanics and machinists is the broken stud bolt, a problem that has been solved by an unusual application of welding. After a year's test by welders William F. Kramer and Alex F. Morton, the method was found 20 times as fast as the previous procedure involving drilling.



Extraction rate: about 20 per hour

The new technique involves the use of arc welding. When a series of stud bolts are sheared off in a casting, the welders place nuts in position above the broken studs and center them In each case the inside diameter of the nut is slightly larger than the outside diameter of the broken stud.

By means of the electric arc, the studs then are built up to the nuts by several layers of weld metal. Then the nuts are welded to the studs.

Where a number of studs have been broken, Morton and Kramer advise welding them all before removing any. This permits the heat from the arc to accumulate in the casting, expanding it and in most cases making removal of the studs as easy as the removal of an ordinary nut from a bolt by a wrench.

RUBBER SAVING

By Common-Sense Practice in Industrial Plants

By following a few simple rules during the war-time emergency, every industrial plant in America can extend the life of its equipment made of rubber, thereby adding to the nation's supply of this vital product, according to a statement issued by W. H. Cobb, of the United States Rubber Company. Every time a plant saves 13¼ ounces of rubber, for example, another gas mask is made possible.

"Certain general rules can be applied to all goods made of rubber," according to Mr. Cobb. "Among the greatest enemies of natural rubber are oil, grease, and gasoline. These are all very destructive, and rubber products should be kept away from them as completely as possible. The life of a conveyor belt, for example, is often cut short by destructive operations such as unnecessary abrasion, misalignment, uncushioned impact, as well as being subjected to leaking oil conditions.

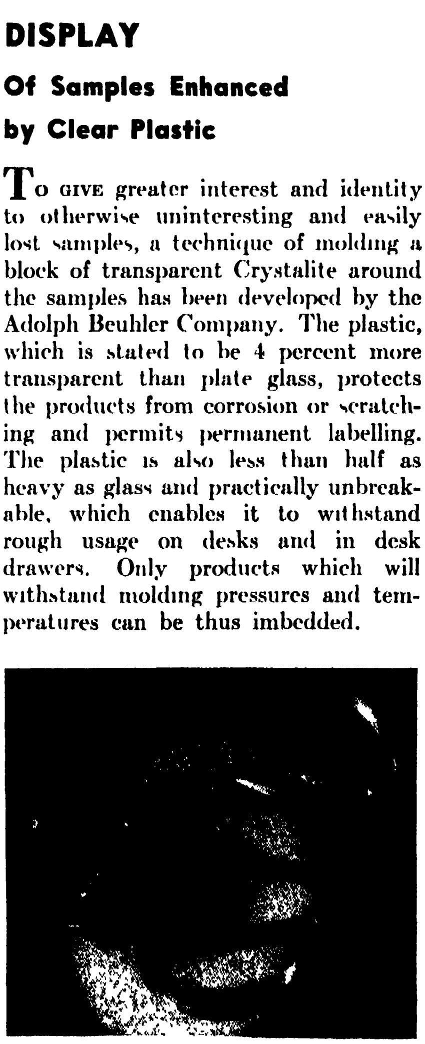
"Also, rubber goods should be stored in a cool, dry atmosphere and kept from sunlight and high temperatures.

"Never place rubber in enclosed generator rooms or near electric motors. If the air around these contains even a minute quantity of ozone, which is created by these machines, it will have an extremely oxidizing effect on hose, belting, packing, and other mechanical rubber products, aging them to an abnormal degree."

DISPLAY

Of Samples Enhanced by Clear Plastic

To give greater interest and identity to otherwise uninteresting and easily lost samples, a technique of molding a block of transparent Crystalite around the samples has been developed by the Adolph Beuhler Company. The plastic, which is stated to be 4 percent more transparent than plate glass, protects the products from corrosion or scratching and permits permanent labelling. The plastic is also less than half as heavy as glass and practically unbreakable, which enables it to withstand rough usage on desks and in desk drawers. Only products which will withstand molding pressures and temperatures can be thus imbedded.



Not Mr. Moto — samples in plastic

INDUSTRIAL TRENDS

WAR, WORDS, PAPER

If records of the paper industry were taken as the only criterion, it would appear that this war, as was almost every war of history, is being fought with paper rather than with hardware. During times of duress, the paper mills hum 24 hours a day, seven days a week, turning out the material on which words are written, with which goods are wrapped. And their associated plants, the pulp mills, work just as steadily to produce a raw material—sulfite pulp—which can be made into paper, or which may become an important ingredient of the explosives that keep wars going.

But we are more concerned at the moment with the product on which words are printed. For several months, now, there have been uncounted rumors about the condition of the paper industry in general, ranging all the way from complete famine to an equally disastrous surplus So let's look into the mechanism of the industry and analyze its present status as it casts a shadow of future operations

Perhaps the best starting point of OPM. From this now dead unit came the estimated demand for paper, during 1942, of 26 million tons of all grades. Present estimates of the paper industry's ability to produce shows a figure of about 21 million tons Is this bad? Not too much so, particularly from the standpoint of the paper manufacturers Past performances indicate that, when pushed by necessity, they are able to pull figurative rabbits out of the hat—rabbits that will, with the co-operation of paper consumers, tide things over until more normal times arrive

There is little need to go deeply into the reasons why wartime brings greater demand for paper and paper products. Pulp, mentioned above, is one of them; increased paper work in government circles, is another, demands on the part of the public for news is still a third. But, again, consideration of this phase of the situation is of little moment here: What is of more immediate interest is why the paper industry is being pushed and what they are doing to meet the demands of wartime.

To gain a more comprehensive picture of the industry, it is needful to survey some of the background. Basis of paper is wood-pulp, except in that relatively small part of the production that uses all or part rag content. Until early 1940, a relatively large part of the pulp used in this country was imported from abroad. Canadian and United States forests furnished the rest. When foreign sources were cut off, there was a fair inventory of pulp available in this country, sufficient to keep up paper production until other pulp sources in the United States and Canada could swing into production.

An over-simplified view of the paper industry shows two main factors: Pulp mills, where the basic wood is converted into a form ready for processing, and the paper mills, where the base pulp is made into various grades of paper. Some companies maintain both mills, integrating the two processes into one "production line" unit. In other cases the pulp is produced by one company and sold to the paper maker In any event, whether the paper producer controls an integrated unit or is dependent upon an outside pulp supply, the effect of war on his business is very nearly the same.

Technological developments during the score of years since 1921 have placed the paper industry in a somewhat better position to meet increased demands than was the case in prior years. Forests of the southern pine regions and of parts of the Pacific Coast, formerly considered worthless for paper making, have become available as sources of pulp. This has been made possible by refinements in processing the raw material so that the resulting pulp will have the requisite characteristics of color and felting that are necessary to produce paper of standard shades and strengths. With these sources of pulp, and with the increasing attention which is being given to controlled cutting of pulpwood and reforestation of cut-over areas, the paper industry as a whole is in a position to meet a large part of the increased demand for its products. And, along with many other industries, producers of paper are gaining valuable lessons through the present emergency. Because of the better business generated by wartime demands, and the consequent increased profits, and because of the technical progress just mentioned, the paper industry as a whole should be in a position to meet most of the requirements thrust upon it during the days of stress yet to come, and to emerge into post-war days with a minimum of dislocation of either pulp production or the manufacture of the finished product.

(A brief comment on the present paper situation, and upon the co-operation which will be necessary between paper manufacturers and consumers, in order that temporary shortages of paper may be dealt with as they arise, will be found on the editorial page, "Our Point of View."

AFTER THE WAR

With all the attention that is being given to war-time production of military and naval needs, it would be shortsighted indeed if industry in general were not giving at least some thought to the course that will be pursued after war clouds pass away and our whole economy must be readjusted to peace-time operations. And regardless of the insistent and necessary cry for all-out production of material of war, conclusion-jumping must not lead to the inference that this thinking-for-the-future is, in one iota, affecting the speed and efficiency with which that all-out production demand is being met. Rather, the two courses, divergent as their ends may be, are supplementing each other, the vision of brighter days to come serving to implement the urge for speed in producing the needs of the moment.

Actually, the two problems involved are identical in almost every respect, and research is the keystone upon which each depends We must have new, faster, better methods of producing, let us say, tanks. Research in metallurgy and welding shows the way to fabricate these monsters of war without the use of rivets. Result: A better tank, produced more rapidly, and safer for the crew that operates it because there no longer are rivets in the structure that can become lethal missiles when struck on the exterior by projectiles. It is not conceivable that this development is being thought of only in terms of tanks: Other structures, for civilian purposes, will feel the impact of this work in postwar days, if not before.

In every industry a similar process is evolving, sometimes subconsciously, sometimes consciously. Regardless of the mental workings involved, American industry always has had a pretty good memory. When it finds a new way of doing something, it is not long before that way is being adapted, in one form or another, to a variety of uses Lessons once learned, no matter what the impetus for learning, are rapidly assimilated to the benefit of many

—*The Editors*

Our Search for the Supernatural

Medium Fails to Appear for Clock-Stopping Test; Dunninger Shows How it Could Have Been Done

A. D., RATHBONE, IV
Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

As stated in these columns last month, it appears at the moment that most exponents of alleged psychic powers do not desire to try to establish basic, truthful, scientific data concerning their so-called phenomena. The belief that this attitude exists is borne out, we regret to say, by the consistent refusal of Signor Raduano to re-appear before our Committee for further study and test demonstrations of his clock-stopping and table-tilting exploits, performed on the evening of July 21st, 1941, in the presence of our investigating body, guests, and representatives of the press. (September 1941).

As we have repeatedly stated, "demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration." This agreement was followed to the letter in the case of Signor Raduano, who was given absolute freedom to perform whatever feats he deemed pertinent, and he was in no way put to any form of test. However, it is also part of the agreement between our Committee and persons who appear to demonstrate alleged psychic powers that the Committee "reserves all rights to request repetition or duplication of the demonstration or seance under its own conditions, at such time and such place as it may designate, and will undertake to the best of its ability to see that its conditions do not hinder or inconvenience the medium or demonstrator. Failure of the demonstrator to comply with the Committee's request to reproduce or to attempt to reproduce phenomena under the Committee's conditions will nullify any claim the demonstrator may file for the award." (April 1941—Regulation Number 4).

Originally, Signor Raduano agreed to re-appear before the Committee After his initial and only demonstration, Chairman Dunninger discussed arrangements with the signor and suggested a choice of two forms of simple tests, to both of which Raduano agreed. Notwithstanding his acceptance of both sets of conditions, however, he has consistently delayed his re-appearance, offering various excuses and, more recently, telegrams and special delivery letters have failed to elicit any response whatever.

As stated, the suggested test conditions were elementary. Dunninger proposed: (1) that the identical clock be suspended in a glass case, in full view of witnesses, but completely enclosed so that no mechanical contrivances could possibly be utilized, (2) that the meeting room be divided by a mesh cloth, through which witnesses could discern the clock suspended from the ceiling in the other half of the room. In both plans it was proposed that no one should touch the clock once it had been placed in position for the test, and to these proposals Signor Raduano acquiesced—yet more than six months have elapsed and the agreement has not been carried out.

As the Committee could not render an official report in the absence of test conditions, we have, in deference to the interest shown in our investigation by our readers, requested Chairman Dunninger to draw upon his broad experience as an investigator of the psychic for a possible and plausible explanation of how this particular clock *could* be stopped solely by mechanical means, under the conditions prevailing at the Raduano demonstration. In presenting this explanation, however, it must be remembered that neither Dunninger nor the Committee claims this method was employed by Signor Raduano on the night of July 21st, 1941 Despite this understanding, and unless and until the signor submits to one of the two proposed tests—according to his agreement—Dunninger's explanatory demonstration will be accepted as conclusive and final in this case.

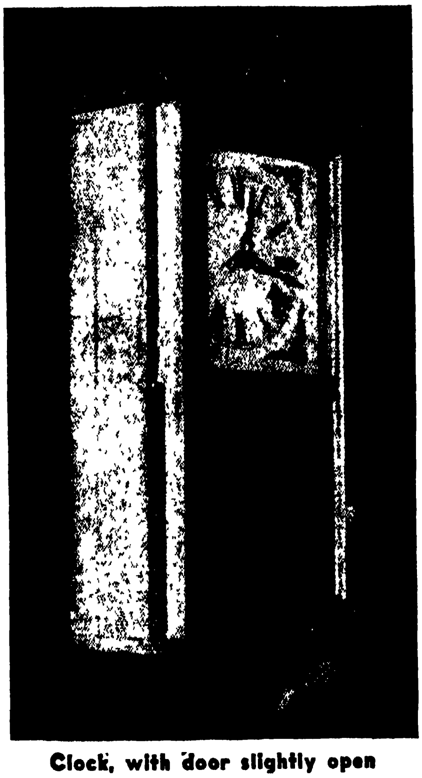
As shown in one of our illustrations, three persons were closer to the clock during the experiments last July than anyone else in the room. Signor Raduano's assistant sat at the left of the clock with his chair not more than a foot or two from the black curtain which had been hung prior to the demonstration at the instigation of the signor. Dunninger sat a little to the left of the timepiece and fully six feet from the curtain. Raduano stood at the right, somewhat closer than Dunninger, but not near enough to touch the clock. The positions of these men are important in expounding this particular theory of modus operandi—particularly that of the assistant, when it is known that the hinges of the clock are on the right-hand side, and that the door, therefore, opens on the side toward the assistant.

Another pre-eminent factor is that although the clock in its entirety—and also the pendulum weight separately—were each carefully examined by mem-

At Raduano demonstration. The signor's assistant at extreme left, close to the curtain. Dunninger is seated in the center, Raduano stands at the right

bers of the Committee, the clock was taken from the wall and replaced thereon by Raduano's assistant. The pendulum weight, likewise, was both removed and replaced by this assistant, who was the last person to touch either the timepiece or the pendulum prior to both of the demonstration attempts.

It therefore would have been entirely possible, pointed out Dunninger in the course of his own demonstration, for the assistant to have quickly and secretly affixed one end of a black thread to the pendulum weight as he replaced it on its hook. A bit of beeswax, kept plastic by the warmth of the hand, or a tiny piece of ordinary chewing gum, would serve as an adhesive between thread and pendulum. To retain the other end of the thread, allowing slack for the motion of the pendulum, and to leave the clock door open but a fraction of an inch, would be the next move in a routine of this sort. Inasmuch as the door opened on the side where the assistant sat, and inasmuch as the opening would be extremely minute and not visible to persons sitting directly in front in the audience, it would be a simple matter for him to manipulate the thread, wholly camouflaged by the black curtain background, in order to stop the clock.



Clock, with door slightly open

It will be recalled that Raduano's first attempt was a failure, which may be accounted for by Dunninger's theory that the adhesive failed to stick, or that perhaps it inadvertently fell from the fingers of the assistant, who could hardly have reached down to pick it up without calling unwanted attention to his strategic position. Anticipating a possible objection to this theory, that if the clock was stopped by this means; the pull on the thread might unfix the bit of adhesive, which would be seen or heard as it fell from the pendulum weight, let it be remembered that (1) the adhesive could not fall *out* of the clock as the door was closed too tightly, although not completely shut, and, (2) the amount of adhesive necessary would be so minute that a drop of an inch or so from the pendulum weight to the bottom of the clock case would scarcely cause an audible sound to people seated a dozen feet away.

From his position at the left of the clock and close to the black curtain, it probably was next to impossible for the assistant to tell exactly where the hands of the clock were. If he were commissioned by Raduano to exert a pull on the thread at exactly 4½ minutes to nine (the time chosen by newspaper men present at the demonstration for the first trial), his visual perspective of the clock hands would be greatly to his disadvantage. How, then, would it be possible for him to know precisely when to exert pressure? We quote from our report of the demonstration (September 1941): ". . . the signor turned his back to the audience, stretched out his left hand, fingers open, toward the obstinate, still moving clock" This action took place in the first attempt just as the hands pointed to 4½ minutes to nine, and it was the first time Raduano, had either turned his back to the audience or extended his arms, both of which had been tensely folded across his chest up to that moment.

In the second attempt, the signor stood in the same arm-folded attitude until—"At exactly 23 minutes past nine (the time chosen was 9:24) Signor Raduano's right hand shot forward in a determined gesture toward the face of the clock. . . . His fore-finger pointed; then the second finger joined the first." Within 30 seconds after this gesture the pendulum wavered, slowed down, and finally stopped. Therefore, states Dunninger, might not the arm gesture serve as the signal to the assistant that it is time to pull on the thread?

In his own explanatory demonstration Dunninger used a bit of chewing gum as adhesive. He displayed the pendulum weight to witnesses, and as he replaced it in the clock, which was hung on the wall, he affixed one end of a special type of thread, known as "magician's thread," and used by prestidigitators in producing their illusions, to the weight with the speck of gum. He then started the clock, closed the door save for an almost imperceptible crack—visible only from the side—and handed the other end of the thread to this correspondent who had been seated in relatively the same position as Raduano's assistant. The thread, even at close quarters against the wainscotted wall and without benefit of the black curtain, was extremely difficult to see, let alone to follow its course to the slightly open door of the clock. Wrapping the thread around his left little finger, this correspondent laid his left hand on his knee, the same relative position as the assistant's left hand, as shown in our illustration. At a signal from Dunninger, the hand was moved slowly and casually toward the hip, tightening the thread. There was a brief feeling of tension to an almost imperceptible degree; the pendulum slowed down, and the clock stopped.

Dunninger displays the pendulum weight and the magician's thread

In conclusion of this month's story, we wish to stress heartily the following statements: The explanation herewith presented is not an official report of our Committee, but rather an explanation requested from our Chairman, Dunninger, of simple mechanical means by which a clock of this type, set up under the conditions described, might be stopped. Neither Chairman Dunninger nor the Committee claims that Raduano used this method, although assuredly it is a feasible one, but until such time as the signor is willing to appear again before the Committee, and in the face of his failure to do so under the above described test conditions—which would certainly preclude use of a thread—we are obliged to accept this theory. However, should Signor Raduano desire to re-appear before the Committee, he will be most welcome

(The subject of table-tilting as demonstrated by Signor Raduano and as practiced by others, will be dealt with in a future issue.—Editor).

Orbit Sleuthing

How the Astronomer Determines the Size and Shape of a Double Star's Orbit

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

FROM the first days of the telescope, astronomers must have noticed that many stars were double. Pairs, some equal and others unequal in brightness, too close to be separated by the naked eye, were clearly resolved by telescopic aid. Rather strangely, no serious attention appears to have been paid to these objects for a century and a half. Finally, about 1780, Herschel began to make measures of double stars—recording the apparent distance and direction of the fainter component from the brighter. His observations were made with the hope of determining the distances of the stars—then wholly unknown. When a bright star showed a faint companion near it, it was assumed that the faint one was much farther away and appeared close to the other only by the accident of its position behind it. If this were the case, the motion of the Earth around the Sun would cause the nearer star to appear to shift back and forth every year, compared to the farther one, just as the frames of a window seem to shift across the landscape beyond as one moves one's head from side to side.

His measures failed to show any perceptible shift of this sort (parallax); but, as years went on, they revealed something far more interesting. In a number of cases the companion star moved steadily around its brighter primary in a curved path. It was not far behind the primary, but was a satellite belonging to it, moving about it in an orbit under the influence of its attraction. The domain of gravitation extended not to the solar system alone, but to the stars. Herschel had made a greater discovery than he had hoped for. He compared himself to "Saul, who went out to seek his father's asses and found a kingdom."

Systematic and intensive study of double stars began with Wilhelm Struve in 1830, and has led to the discovery of more than 20,000 pairs. Knowing the number of stars of a given magnitude in the whole sky, found by actual counting, it is easy to calculate in how many cases two stars of, say, the 6th and 8th magnitudes should be within, say, 10″ of one another, provided they were sprinkled quite at random over the heavens. It is thus found that only a small fraction of the observed number of double stars can be "optical" pairs, due to chance, with one star really far behind the other. The great majority must be "physical" pairs, not much farther apart in space than they look. In a great many cases the physical connection is proved by the fact that the two stars are moving together across the sky with a common proper motion; and there are more than 2500 pairs for which slow orbital motion has been detected. The number for which even tolerably good orbits have been calculated was 166, two years ago (at the time of an extended study by the writer), and is probably about 170 today.

WHY should this difference be so great? The obvious answer is that most double stars move so slowly that they have not had time to go around their orbits, or to complete any considerable fraction of a revolution, in the short interval of 112 years for which there are reliable observations. Unless our observations cover a considerable fraction of the whole circumference of the orbit, we can get no reliable results. This may seem strange, when, in the case of a planet, such as Pluto, a good determination of the orbit can be made from observations extending over only a few percent of the period.

The main reason for the difference is that the observations of a planet are of an enormously higher percentage of accuracy. It is easy to observe the position of an asteroid in the heavens to a second of arc, that is, to less than a millionth part of the circumference of the celestial sphere. By the time it has advanced one tenth of the way around its orbit, the observations determine the angle through which it has moved to better than one part in 100,000. With data of this precision, refined analytical methods may be employed, which, despite the complications arising from the fact that we observe the planet from the moving Earth, lead us to our goal. But the percentage of precision of the observations of a double star is low. Most of the rapidly moving pairs can be separated only with powerful telescopes, and never appear as much as 1″ apart. An accuracy of about 5 percent in the measures of distance, and a corresponding uncertainty in the "angle of position," is all that can be expected from even good observations.

Now the real orbit is an ellipse, with the bright star at one focus. It is not at all likely to be seen squarely, "in plan"; its plane is almost always tilted at an angle to our line of sight, so that we observe a foreshortened orbit—still elliptical in form, but with the star not at the focus. Occasionally we see the orbit edgewise, and the smaller star appears to oscillate from one side to the other of its primary along a straight line.

TO FIND the size and shape of the real orbit from the foreshortened projection of it which we observe, is a purely mathematical problem, which has been solved in more than a dozen different ways—all correct, but some quicker and more convenient for the calculator than others. To work this through takes but a few hours.

But to draw the apparent ellipse from which the calculations start is much more difficult. If we had observations covering a whole period, and fixing points all round the orbit, even with low accuracy, it would be easy enough to draw an ellipse to represent them; but astronomers, being human, are impatient, and do not like to wait for decades, or perhaps centuries, until this has happened. They naturally want to determine the orbit from as small an arc of the whole ellipse as possible and here the errors of observation become troublesome.

For motion along a straight line, things would not be so bad. Given a number of observations—represented by the dots in *A*, Figure 1—not only the position of the mid-point of the line, but its direction are determined with fair accuracy. But if, as in *B*, we have to represent these points by a circle which passes as close to them as possible, our results are far less accurate. The mid-point of the observed arc, and the direction of the tangent there, can be determined nearly as well as in the case of the line. But the radius of the circle, or, what is equivalent, its curvature away from the tangent, is badly determined. The observed arc is but a small part of the whole circle, and an arc of a circle of considerably larger or smaller radius can be drawn so that within this small range, it deviates from the first circle by less than the errors of the observations. Even a straight line would give a fairly good-looking, though not a satisfactory, fit.

For an ellipse the case is much worse, for its complete specification depends on five quantities (instead of three for the circle), and it is possible to draw great numbers of ellipses, very different in form and size, which all lie so close to the circular arc that they could hardly be distinguished from it within the small observed region. This is illustrated in *C* (copied from one of the beautiful diagrams in Burnham's "General Catalogue of Double Stars"). The circular apparent orbit, which gives a period of 300 years, and the ellipse with a period of 130 years, represent the observations from 1830 to 1900 equally well. Later observations show that the companion has been moving a little outside the smaller ellipse, and that the period is about 150 years. The law of areas holds true in the apparent orbit; hence the period corresponding to any ellipse can be found by comparing its total area with the area swept out by the line joining the stars in a known time.

With ordinarily good observations, such as are shown in *C*, it is rarely possible to fill in the remaining portion of the apparent ellipse with any assurance until the observations cover about half its circumference. With more accurate observations, a shorter arc should suffice.

The most precise method of measuring the relative positions of the stars is by photography, but photographing double stars is peculiarly difficult. To begin with, the image of a star on even the best plates is very much larger than the optical diffraction image in the focal plane. This happens partly because the photographic action spreads on the plate, partly because, even with the steadiest air, the star-images dance about a little. The visual observer can take advantage of the best moments when the images are sharp; on the plate, the good and bad moments combine to produce a smeared-out image. Close doubles therefore are the exclusive province of the visual observer. Somewhat wider ones show on photographs as elongated images, unsuited for measurement. Even when the two stars are just separated upon the plate, there is trouble. The photographic effects on the inner edge of the two images may overlap, bringing them too close together. On the other hand, the developer may be partially exhausted in this region of the plate, and act more strongly on the outer edges of the images—which makes their apparent centers too far apart.

Practical experience has shown that these effects spoil the accuracy of the photographs, unless the images are approximately $\frac{1}{8}$ of a millimeter apart. With a focal length of 10 meters—a big telescope—this corresponds to $3''.5$. Pairs as wide as this have usually been observed with small telescopes, as observers who have larger ones naturally work on the close pairs which the small instruments cannot separate; but this is no longer the case.

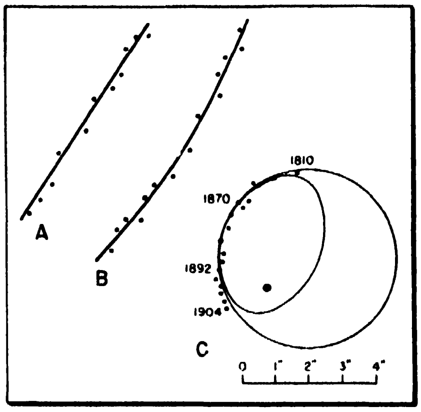


Figure 1: Working principles

The first serious photographic measures of double stars were made in 1914 by Hertzsprung and showed at once that a previously unprecedented accuracy was within reach. Fifty or a hundred exposures can be taken on a single plate, so that the random errors are greatly reduced in the mean. Difficulties due to atmospheric dispersion—which raises the apparent altitude of blue stars more than red ones—can be eliminated, and the sharpness of the images improved, by photographing through a yellow screen, which transmits only a narrow range of the spectrum. If the components are of unequal brightness, the images of one will be under-exposed, or of the other over-exposed, with serious loss of accuracy. This is avoided by placing in front of the objective a coarse grating, consisting of narrow metal bars, equally spaced. Observed through this each star image is flanked by fainter ones on each side (actually very short spectra) whose mid-point coincides exactly with that of the over-exposed central image. The difference of brightness between these and the central image depends on the ratio of the width of the bars to that of the spaces between them. With three or four suitably designed gratings, it is always possible to pick one such that the brightness of the lateral images of the bright star is nearly equal to that of the companion. Accurate measures can then be made with only a little extra work.

Hertzsprung's work has been continued, first in Holland and then in this country, by his pupil, Dr. K. Strand, who has specialized upon bright, slow moving, binary stars. For such pairs, the photographs give positions whose errors are hardly more than a tenth of those of the old visual measures.

Observations of this sort, continued over a decade or two, fix the position of the corresponding portion of the orbit so accurately that there is far less latitude left in drawing the ellipse, even though the observations cover but a small part of it.

Dr. Strand has in this way determined reliable orbits of a number of well-known, but slowly-moving pairs, for example Eta Cassiopeiae (period 526 years) and Castor (period 380 years). He has just reported success in what has previously been regarded as a hopeless case—61 Cygni.

This is the first star whose distance was measured—by Bessel in 1838—and still ranks as one of our nearest neighbors. The relative motion of the pair has been carefully followed for the past 110 years, but shows so slight a curvature that no one has been bold enough to extend the observed arc into the whole ellipse.

Modern photographic observations from 1914 to 1941 have been supplemented by measures on photographs taken by Rutherfurd in New York between 1871 and 1874.

Utilizing these, and a great mass of visual measures, Dr. Strand finds a period of 720 years, and a mean separation, after allowance for foreshortening, of $24''.64$—the largest yet found for any double star orbit. The real separation corresponding to this is 84 astronomical units, and the combined mass of the two stars 1.16 times the Sun's—which is what might be expected, as they are red dwarfs, much fainter than the Sun.

The system is approaching the Sun at 63 kilometers per second, and after 720 years its distance will have diminished by one part in 75. Hence, when the astronomers of the future observe it in the same part of its orbit, the companion will not appear to follow exactly the same track, but one $0''.3$ farther from the center. Followed through further centuries, it will appear to move in a slowly expanding spiral, till, at long last, the star reaches the point on its track nearest the Sun.

Fidgety Atoms Purify Water

Ozone Treatment of Community Supplies Has Proved Efficient in Practical Applications

R. G. SKERRETT

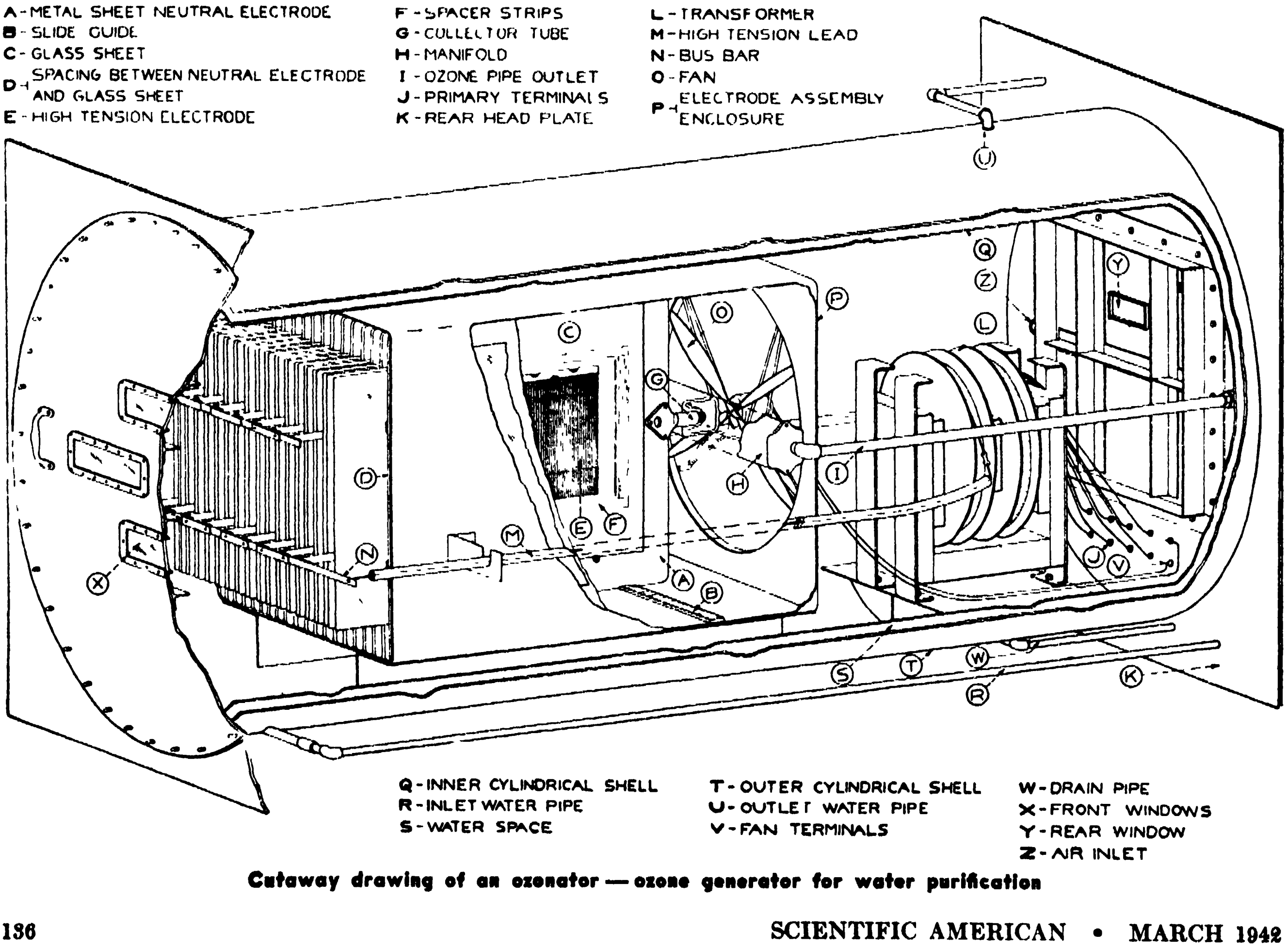
Ozone, today, has attained both industrial and technical significance, thanks to the joint labors of electrical and mechanical engineers. As a result of these collaborative efforts ozone, among other applications, is now making it possible to transform unpalatable water into a hygienically suitable liquid that is completely acceptable to discriminating tastes—a matter of vital interest to a steadily increasing percentage of the nation's population As the sizes of communities grow and existing water supplies diminish relatively, the problem of pure water and plenty of it is becoming more pressing year by year. To offset deficiency, water must be sought from sources that may be polluted—and the responsible sanitary engineers have to resort to treatments, chemical and otherwise, to remove the impurities. Because of the percentages of chemicals used, such water, when delivered to the householder, for example, may have a decidedly unpleasant taste Here it is that ozone now comes into the picture.

Perhaps what ozone can do can best be understood by describing how it has helped in two cases. Denver, Pennsylvania, a community of 2100 people, for many years relied upon spring water to meet its needs Then, increased consumption necessitated the damming of a nearby creek and running that occasionally turbid water through a sand-filtering plant having a daily capacity of 300,000 gallons During a drought in 1939 the lowered water of the creek developed disagreeable odors and tastes that persisted after the water had been filtered and sterilized by chlorination The citizens of Denver complained loudly: to provide corrective measures, ozonation equipment was installed. The plant has a rated capacity of five pounds of ozone daily; and, small as that may seem in comparison with 300,000 gallons of water per diem, the effectiveness of the ozone was equal to the situation, and the water was found entirely satisfactory to Denver's people.

Whiting, Indiana, put the ozone treatment to a still more difficult test. Whiting is a city of 11,000 people that draws its water supply from Lake Michigan in an artificially created basin flanked by two steel bulkheads jutting out from the shore line and spaced several miles apart. Into that partially enclosed water area is discharged most of the waste of 150 industrial plants.

Pollution is further increased by the sanitary sewage of 250,000 people living in the neighboring region, through which flows the Calumet River. Raw water for Whiting enters an intake about 1400 feet offshore, and, prior to 1939, this lake water was filtered and treated chemically to make it safe for use. But when it reached the consumer, it had objectionable odors and an oily, tarry, and phenolic taste. Something had to be done, and the local authorities decided to try ozone

A pilot ozone plant was installed and for more than a year was run success-



Cutaway drawing of an ozonator — ozone generator for water purification

Illustrations courtesy Ozone Processes, Inc.

***Left:* Five ozonators and control panel. *Right:* Upper sections of two ozonizers**

fully under the varying seasonal conditions and consumption demands, which ranged daily from 2,000,000 to 4,000,000 gallons of raw water, first passed through a filtration plant. Before the test was started, the established treatment of the water followed these stages: aeration; preammoniation, just before prechlorination; prechlorination; coagulation with alum; mixing in a baffle tank; sedimentation in two large tanks; rapid sand-filtration in six gravity filters, and then, when needed, final chlorination—this last chlorine treatment imparting to the water its particular added measure of taste and odor. Because of the effectiveness of the ozone pilot plant, the city contracted for ozone-generating equipment consisting of five units, each having a rated capacity of 10 pounds of ozone a day, although actually able to produce 16.5 pounds every 24 hours.

PREVIOUSLY, at Whiting, chlorine was applied at two stages in the purification process in order to combat the normally heavy initial pollutions of the raw water and to assure proper sterilization before turning the water into the city mains. The ozone plant was primarily added to eliminate bad tastes and odors but, in the end, some of the ozone was used as a sterilizer, and so brought about a very substantial reduction in the use of chlorine, alum, and ammonia. The changes effected have been summed up: "The days of consumer complaints and the extensive use of bottled spring water were ended. For now, Whiting, despite the well-nigh impossible conditions governing its supply, had an acceptable and safe drinking water."

Normal oxygen and ozone—which is born of oxygen—differ in their make-up. The oxygen of the free air is represented by the symbol O_2—the numeral indicating that the molecule of oxygen is a union of two atoms of oxygen—while the symbol of ozone, O_3, indicates that a molecule of ozone is made up of three atoms This third atom in ozone is not strongly attached to the two other atoms, and, with suitable provocation, will break away from the combination and hungrily attack any nearby oxidizable substance. The main difference between oxygen and ozone in oxidization is that ozone is far and away the more active agency. Due to this vigorous oxidizing action, ozone is a powerful germicide, peculiarily valuable in rendering tainted water fit for human consumption. This is not a new discovery: Europe has led us for the better part of half a century in this use of ozone, but its application to water purification on a large scale is decidedly recent in this country.

Ordinarily, in purifying water by any of the commonly employed methods, oxidation is one of the stages of treatment; sterilization and precipitation of suspended organic matter are brought about by the use of chlorine to deal with bacteria, and the employment of alum to induce precipitation. Chlorine, because of the quantity necessarily used, leaves an after-taste that is objectionable to the domestic user However, ozone is able to destroy disease-causing bacteria as well as to rid water of offensive odor and unpalatable taste. That fidgety third atom, which characterizes a molecule of ozone when it breaks away from its two associate atoms and becomes a "free agent," does its good work rapidly in attacking oxidizable matter and then disappears without leaving any trace of itself behind.

Ozone is today generated by the most improved process in an ozonator to which compressed air is delivered in a prescribed condition of cleanliness and dryness The air is passed through a silent blue corona discharge which is induced between electrodes on the opposite sides of a dielectric plate operating at from 8000 to 16,000 volts. Just what happens to the air so exposed to the discharge is not fully understood, but that need not concern us at this time. An accompanying diagram reveals the essential features of an up-to-date ozonator: the air that issues from it carries about 0.5 percent ozone. Still under some of its initial pressure, the ozonized air is then piped to an ozonizer to meet the filtered water that is to be treated.

The ozonizer, shown in one of the photographs, and not to be confused with the ozonator in the diagram, is an upright cylindrical tank into which water enters at the top, and in dropping meets the rising ozonized air which is discharged from nozzles near the bottom of the cylinder Power-driven paddles, placed midway in the contrary courses of the water and the ozonized air, induce thorough mixing of the fluid and the gas, and the treated water is drawn off from the bottom of the tank That water, according to given conditions, may undergo further treatment before being turned into the distributing system of the local community, or it may be led directly into the mains.

AT the present time, the city of Philadelphia is operating a pilot test plant at its Lower Roxborough filter station to ascertain how far ozone may be depended upon to "sweeten" raw water drawn from the Schuylkill River which, because of industrial wastes, has an objectionable chlorophenol taste when distributed to users. Actual performance figures cannot be disclosed at this time, but ozone will probably be found the means of bringing about the desired betterment, for the conditions at Philadelphia appear to be easier to master than those that prevailed at Whiting before ozone was tried and proved to be a satisfactory hygienic agent in that city.

Excavating for Meteorites

One Large and Two Small Craters Made by Violent Impact are Under Geologic Exploration in Texas

Excavations at the site of three meteorite craters, a large one and two small ones, nine miles southwest of Odessa, Texas, recently have attracted geologists and tourists to the sand-hill dotted prairies in the western part of the state.

Discovery of two new craters adjacent to the giant pit, which has been under exploration for two years by field crews from the University of Texas with the assistance of the Work Projects Administration, has heightened interest in the study of the phenomenon.

All three meteorites are believed to have crashed to the earth about 40,000 years ago, their terrific speed resulting in a concussion far more than comparable with that caused by the bombs of modern warfare

The main crater, second largest in the United States, has been studied and explored since 1939. It is about 500 feet in diameter at the level of the earth's surface and 50 feet deep. The meteorite itself, according to Dr E. H. Sellards, director of the University of Texas's Bureau of Economic Geology, who is in charge of the project, has been determined to be about 164 feet below the bottom of the crater

One of the newly discovered craters is 70 feet in diameter and about 17 feet deep, and contains as many as "six to seven thousand meteorites with a total weight of about six tons," Dr Sellards estimates. He believes that the crater was caused by the smashing into the earth of a closely packed swarm of small meteorites, rather than by a single mass breaking into thousands of pieces as it struck.

The other pit is similar in formation but smaller. The two new craters were discovered last Autumn, hence there has been no time to make an exhaustive study.

Under the direction of Dr. Sellards and Glen Evans, assistant, 35 exploratory drill holes have been put down in and near the main crater. Observations have also been made from additional trenches cut at the sides, and from core drilling.

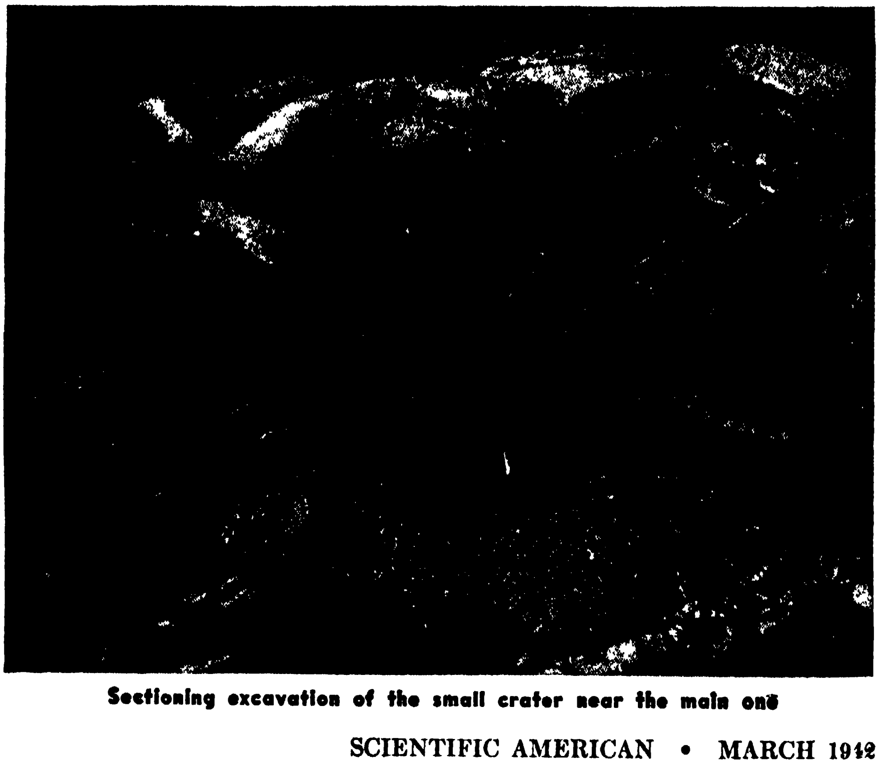
An elevator shaft is being sunk in the center of the crater. When it is completed, visitors will have an opportunity actually to see the meteorite fragments. Present plans are to maintain the site as an educational exhibit open to the public, when excavations are completed.

From their observations of the main crater, Dr. Sellards and Mr. Evans have determined that rock from as deep as 70 feet below the surface was thrown out by the impact of the meteorites. Also, that all rock strata in and immediately around the crater were moved from their original position, and that rock strata forming the crater walls were lifted, broken, folded, and faulted. "On the surface, the rock debris is chiefly blocks of limestone, often covered and cemented together by caliche," they state in their report on the progress of the investigation. "Pits and trenches cut outward from the rim show that large blocks of shales are included with the limestones Search among the rock debris enables one to recognize rocks coming from various parts of the geologic section of this locality down to a depth of about 70 feet. The largest of the limestone blocks are three or four feet across Some of the shale masses are of equal size and larger. Many of the limestone boulders have disintegrated, and the shale persists only when protected by overlying debris. At some places a secondary accumulation of caliche cements the ejected rock, indicating considerable length of time since the crater was formed and the rock thrown out. The maximum thickness of the debris around the rim is now 10 or 12 feet It was doubtless thicker when the crater was first formed.

"At the present time the crater is filled within five or six feet of the level of the surrounding plain. The latest fill consists of fine, red, incoherent silt with some fine sand. The stratum is lens-shaped, having a thickness of 25 to 30 feet at the center and thinning out to the margins. Some of the sediments are of a degree of fineness such as to indicate that they probably settled from the atmosphere slowly, while the others are coarser and were probably wind-blown. This stratum of silt and wind-blown sand, with few pebbles and little or no caliche, readily separated throughout the entire crater from the older, more consolidated and more or less calichified underlying sediments.

"Next underlying the silt is a stratum, lighter in color, which consists in part of silt with which is included pebbles and pieces of rock washed in from the rim of the crater. Caliche has formed in this stratum, resulting in partial cementation In the central part of the crater this material is 45 to 50 feet thick. The definite line of separation between this and the overlying stratum, together with the difference in texture and origin, suggest that an appreciable time interval separates them.

"Some of the rock thrown out by the meteor fell back into the crater. In the



Sectioning excavation of the small crater near the main one central part of the crater this stratum of fragmental rock at the bottom of the crater is 10 or 15 feet thick and is readily distinguishable from finer materials above and below."

Immediately below the fragmental rock, they say, is a stratum of rock flour. "In this zone the sand grains were completely shattered by the meteor so that, when rubbed, they remain only as a coating on the hand," the report states, "The rock flour is thickest near but somewhat northeast of the center of the crater. From its place of maximum thickness it thins in all directions, forming a lens lying within and not extending to the margins of the crater."

The conclusion reached by Sellards and Evans is that the rock flour is shattered limestone, and that the impact which shattered the sand grains may have originated from the vibration waves.

The land elevation at the crater is near 3050 feet. The greatest depth at which rock flour was found by drilling is at an elevation of 2916.9 feet, or about 108 feet from the plain's surface. The meteorite encountered in drilling lies at an elevation of 2880 feet, or approximately 67 feet below the lowest known rock flour and about 170 feet from the original surface

Placing plaster around one of the meteorites to remove it safely

A magnetometer survey, verified by drilling, indicates that the principal meteorite masses lie very nearly under the center of the crater.

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WEED KILLER

For Lawns, Does Not Injure Grass

A chemical weed killer which does not permanently injure grass, yet is claimed to rid lawns of practically all common weeds, is applied in liquid form by spraying it over the surface of the lawn Exhaustive field tests of this material, known as Lawn Sinox, have been conducted in co-operation with agricultural colleges and experimental stations.

After a lawn has been sprayed according to directions, a temporary browning of the lawn grasses will be noticed. This condition exists for from several days to two weeks but the lawn grasses will fully recover while the weeds will not.

BATTLING BATS

Bright Lights Solve a University's Problem

For more than 25 years, bats have been a problem in the buildings now occupied by St. Mary's University, San Antonio, Texas. They infested the attics, or worked themselves into the very narrow space between the metal roof and the sheeting, or attached themselves behind rain-spouts, or even entered below the window sills and behind the window frames. Efforts have been made periodically to get rid of them, with little success But the problem has finally been solved, quite simply, by making use of bright lights

Efforts made at St. Mary's to dislodge the bats, without injuring or killing them, yet to keep them away permanently, fall roughly into four classes, according to a recent communication from W. R. Lamm, S.M

Disturbing the bats during the day and keeping them moving was only partially effective. Soaking the bat lodging places with kerosene or creosote or pressing lime into them was effective for only a short time. Noises of various types—bells, buzzers, whistles, supersonics, radio, and the like were partially effective; the bats left for a while but came back again. Furthermore, the noise was as annoying to human beings as to bats.

The fourth method solved the problem. Bats don't like light. They roost in dark places and leave the roosts at night, returning at dawn. Hence bright lights were placed at the opening where the bats entered and left the building and these lights were turned on in the morning when the bats were returning. Within a few days all the bats were gone and did not return. Should they do so, the lights will simply be turned on again and will be kept burning for about 45 minutes every morning and evening. The method is effective, simple, inexpensive, safe, and not bothersome to the human beings in the buildings.

LO, THE SWOOSE

Or you Might Call it the Gwan

The swoose, a hybrid between swan and goose, was one of a strange Noah's Ark of cross-bred fowl recently paraded before an audience of geneticists by Dr. Charles W. Knox and Dr. Joseph P. Quinn of the United States Department of Agriculture. Another was a hybrid of guinea-hen and ordinary barnyard fowl, which you may call guin-hen, or guiowl, or guicken, as best suits your fancy, says *Science Service*.

The swoose is a very peculiar-looking bird, Dr. Knox stated, intermediate between goose and swan in size and shape, but with the swan's long neck. Sweese (presumably that's the proper plural) have been produced several times in the past The first one on record was described by the famous French naturalist Cuvier, in 1808, and there have been a half-dozen scientifically authenticated sweese since that time.

Since they are incapable of normally rapid reproduction, the hybrid birds have no economic future, and are of interest mainly as scientific curiosities. This is a pity, at least as regards the guinea-hen-chicken hybrid, because most specimens are much bigger than either of the parent stocks—sometimes twice the weight of the heaviest parent.

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LEG BANDS: Metal substitutes have even reached the chicken farm. Leg bands, identifying markers used by poultrymen and formerly made of aluminum, are now being fabricated of various plastics or of soft metal composition.

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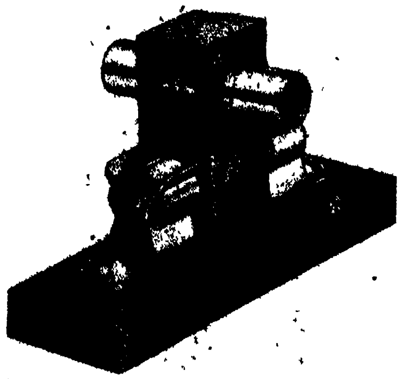
FUSE-CHANGING

Made Convenient With New Holder

Entirely new convenience for changing fuses in close quarters—replacing a blown fuse in a twinkling and giving notice on inspection that another spare is required—are features embodied in a spare fuse holder and puller combined, just announced by Littelfuse, Incorporated.

The fuse in circuit goes through one end of the soft rubber rectangular holder, between the clips. Above, and at right angles, is an opening in the holder for the spare fuse. When inserted, the caps of the spare fuse project beyond the holder, affording an easy grip for two fingers.

When the fuse in circuit blows, all the operator has to do is to pull and reverse the Littelfuse holder. This puts the spare fuse in circuit and brings the blown fuse on top in the same position that the spare was in before. One end of the holder is painted red. Until a fuse change is necessary, the red end is underneath, out of sight. When a reverse is made, putting the spare fuse in circuit, the red end is brought into full view on top. To an inspector or service man this red signal indicates that a fuse has blown and that another spare is required.



The spare is right there

SLIDE RULE

Adds, Subtracts, And Converts Decimals

An aid to making and checking calculations for mechanical drawings, laying out machine-shop jobs, making patterns, and so on, is to be found in a new calculating device, known as the Sum-Up Slide Rule. Unlike the usual slide-rule which multiplies and divides, this new device adds, subtracts, and converts decimals of an inch, fractions, and millimeters interchangeably.

MILEAGE

Determined For Average Stock Car

A new car is a new car, if you can get one, but—breathes there a motorist with curiosity so dead who hasn't wondered how much mileage was left in the old one?

In a four-month road test on a fleet of 1940 stock cars, oil company researchers found the answer—mileage up to 112,000 miles—and still going strong. During the test period in which the cars were driven night and day at an average speed of 50 miles per hour over a 171-mile Florida course, top speed was two miles less than when the cars were new and mileage per gallon of gasoline was better! No carbon was cleaned throughout the test.

At 10,000 miles the fleet made 18.5 miles per gallon on an average; at 75,000 miles 19.1, and at 100,000 miles it was 18.9. Gasoline economy increased as driving speed increased up to about 20 miles per hour, and then fell off. In 10,000 miles of driving the anti-knock requirement increased from 64 to 73 octane and at 50,000 miles it leveled out to about 75 octane. With suitable fuel, lubrication, and servicing the cars maintained throughout at least 100,000 miles what is—for all practical purposes—new-car acceleration time.

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HEAT LOSS—Approximately 50 percent of loss of heat in a home is due to air infiltration through the walls. Plywood panels 5/16 of an inch thick have about twice the insulation value of ½-inch plaster on lath.

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CURIOSITIES

Of the Laboratory Meet Commercial Demands

Two new industrial chemicals—sulfamic acid and ammonium sulfamate—costly laboratory curiosities only three years ago with few known practical uses, are now in tonnage production at du Pont's recently completed Grasselli, New Jersey, plant. Formerly produced on pilot plant scale, sulfamic acid and ammonium sulfamate proved themselves valuable in many industrial processes. An interesting application of the latter chemical has been in its wide adoption as a fire retardant in textiles, insulation products, and paper. While flammable material treated with ammonium sulfamate will char upon contact with flame, it will not blaze. Thus the treated material will not support fire.

Clothing, curtains, and draperies are being "flame-proofed" with ammonium sulfamate by many laundries and dry-cleaning houses, while workers' uniforms in plants where fire-hazard is high are being protected on an increasing scale, the manufacturers point out.

Ammonium sulfamate, though harmless to humans, has proved itself effective in killing weed pests such as poison ivy, ragweed, and thistle, without injuring the soil.

Sulfamic acid is valuable in leather tanning, for nitrite removal in the manufacture of dyes and color lakes, and also as a laboratory reagent.

Chemists explain that sulfamic acid utilized in the bating, pickling, and tanning processes of leather results in a silkier and tighter grain. This white crystalline solid is odorless, highly soluble in water, non-volatile, and non-hygroscopic.

CLEAR WATER

At All Times, In Metal Containers

By adding a small quantity of a harmless chemical to water that must be kept in metal storage tanks, all formation of rust and corrosion is prevented; when the water is withdrawn from such tanks, it comes out just as clear as it goes in.

The chemical used for this purpose is commercially available under the trade name Aqua-Clear. In the case of old and rusty tanks, a few treatments will clean out the old rust and the water will flow clear as long as the film deposited on the tank interior by the chemical is maintained.

Use of this clear, tasteless, harmless liquid is advocated for drinking water tanks in boats, in hot-water heating systems to prevent rust and corrosion in the pipes and radiators, and in automobile cooling systems.

PROJECTED WRITING

For Use by Teachers and Lecturers

A class room lecture desk which allows one to write on cellophane stretched over a plano-convex lens on the desk top and have his writings projected onto a large screen on the front of the desk, may change future methods of visual education.

Invented by David Katz of Wil-

"Scriptoscope"

mington, Delaware, this desk, called the "Scriptoscope," enables a teacher or lecturer to illustrate his discourses without turning his face from the audience. Sitting at his desk, he draws his sketches or diagrams with a wax pencil on rolls of cellophane stretched across a 10-inch lens.

A beam of light from above the desk is directed through the plano-convex lens; a system of lenses and mirrors intercepts this beam and projects it on the screen.

The screen, about 24 by 30 inches, may be built above or below the desk top. It may be used in a well illuminated room or in daylight, provided it is shielded from direct rays of the sun.

The rolls of cellophane give a permanent record of a lecture, and may be used for reviewing without again rewriting all the material. Pre-fabricated diagrams and sketches, especially complex ones, may be drawn before a lecture and slipped under the cellophane; and the lecturer may write what he wants on the cellophane without spoiling the diagram.

• • •

INSECTS—Damage caused by insects may be conservatively reckoned at two billion dollars annually in the United States.

• • •

GEMS

The American Indian Was a Gem Collector

Some of the fanciful accounts of Indian wealth in jewels which excited the cupidity of Europeans had a basis in fact, according to a study of Indian mining by Sydney H Ball, published by the Bureau of American Ethnology of the Smithsonian Institution.

He made use, Mr. Ball finds, of at least 84 kinds of gems and artificial stones and his acquaintance with minerals suitable for decorative purposes exceeded in number that of the peoples of Europe and Asia at the time of the discovery of America. The Indian also was the first to use platinum.

Like most primitive peoples the Indian saw in gems and decorative stones not only beauty but the supernatural and awe-inspiring. Among the pre-Columbian aborigines of Ecuador a large emerald was worshipped, and rock crystal and jasper appear to have served the same purposes among certain Peruvian tribes until they were forced to adopt Inca sun worship.

Diamonds, according to one account, were used by a tribe of Brazilian Indians as playthings for their children Emeralds were used ornamentally in Colombia, Venezuela, Ecuador, Bolivia, Peru, and Panama. The Colombian emerald mines had been worked for a long time before the Spaniards conquered the country. The mining season was inaugurated with religious ceremonies and only certain persons were permitted to dig for the gems.

Eskimos believe that quartz formations are ice so solidly frozen that it has become stone

Makes old oils and greases better than new for the Army

USED OIL

From Crankcases Reclaimed In Mobile Unit

A mobile oil refinery designed to purify used crankcase oil from more than 3000 military vehicles per month received its first test under maneuver conditions in South Carolina. Capable of refining approximately 200 gallons of used oil per day, the unit turns out a product which Army experts consider as good as, or superior to, the original oil. Impurities, such as water, gasoline, and grime, are removed during the process.

The used oil is dumped into a 100-gallon vat where it is mixed by an electrical mixer with Fuller's earth, a compound which absorbs the impurities. The mixture is then drawn by vacuum into a retort tank where it is heated to a temperature of 650 degrees. Gasoline, water, and other liquid impurities vaporize under this heat and are drawn off, also by vacuum, into a condenser tank where they are returned to a liquid state The liquified impurities are then removed into a dilution tank The oil, still at 650 degrees, is run through 50 feet of coils to cool, and then back into a tank. After the mixture has been cooled down to about 325 degrees, it goes into a cylinder where presses separate the Fuller's earth from the newly-refined oil. The viscosity of the oil depends, mainly, on the original product, but operators of the mobile refinery reveal that tests have shown the average weight to be around S.A.E. 30.

At present, the refinery accepts all oil and grease waste, including used crankcase oil, transmission grease, and other oil derivatives. The loss during refining is estimated at about 10 percent but operators believe that, given only crankcase oil drawn from vehicles, the loss in bulk would not exceed 5 percent.

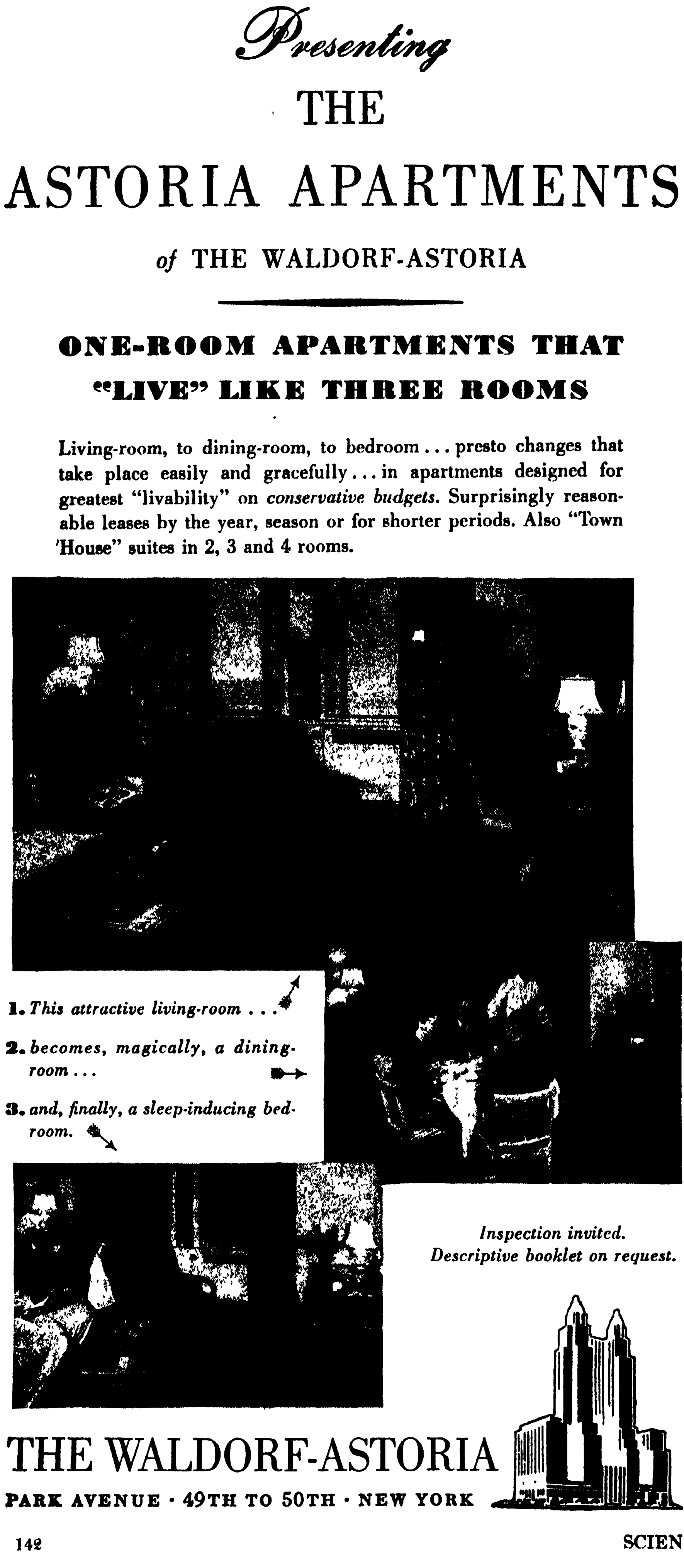
The refinery carries its own generator mounted on a trailer, but the mechanism is designed to operate on either A.C. or D C.

TIRED TIRES

Have Weak Cords in Carcasses

Tires get tired. After several thousand miles of use, the tensile strength of the tire cord begins to diminish. As the tire mileage increases, the danger of blow-outs increases. The loss of strength of the tire cord is called "cord fatigue."

To test the tensile strength of cord in a tire, a scientific and accurate device has been perfected. Called the Tensile Meter, this machine is gradu-



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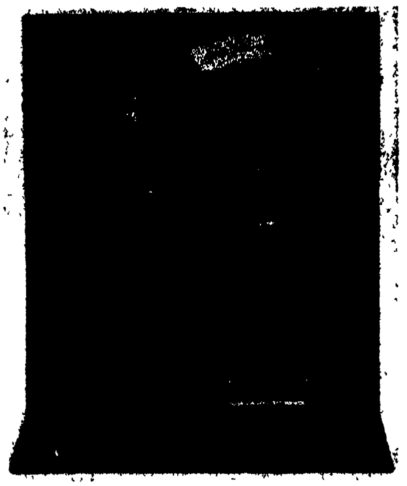
ated in pounds and has a dial divided into three zones—green for safety, orange for caution, and red for danger. When the cord is broken, the hand remains in a stationary position and indicates the tensile strength of the cord. If the hand remains in the safety zone, this indicates a cord test of over 12 pounds; if in the caution zone, the cord will test between 10 and 12 pounds. Should the results find the hand remaining in the danger zone, the cord tests below 10 pounds and the carcass is not safe or suitable for retreading. The cord to be tested can easily be removed from the tire from the inside splice where it overlaps. Either fabric or rayon cords can be tested.



It shows if tires are tired

PROTECTING

Film For Record Cards Of All Kinds

Record cards that must be referred to frequently can be protected from dirt and moisture by covering the surface with a new film manufactured by Seal, Inc The film, which is applied by an electrically heated device, is practically invisible, is flexible, and is moisture-proof. Temporary notations can be made on the surface of the film with a colored wax pencil and then wiped off

LENS

Automatically Keeps Objects in Focus

Although the living eye, with its elastic lens, automatically focuses objects at varying distances, optical engineers have looked askance at many ingenious proposals to accomplish this purpose in a photographic lens. But a four-element motion picture lens has now been designed by Bausch & Lomb in which one double-concave element is electronically oscillated on its axis by means of a special cell mounting developed by P. Stanley Smith, a New York radio engineer.

The oscillating element is confined to a movement of three-tenths of a millimeter but the oscillations are at the rate of 23,200 times per minute, thus continuously altering the focus so that all objects are uniformly in register from four feet to infinity. Although all objects are slightly softer in focus than with conventional lenses, many photographers regard this as an improvement

The new oscillating lens cannot be incorporated in hand cameras

PHOSPHORESCENT

Paint For Use In The Home

Many are the uses to which phosphorescent paint can be put in the home, the home workshop, and even in offices and manufacturing plants Dangerous corners can be spotted or outlined with paint that glows in the dark, electrical switches can be coated with the substance, house numbers can be made to glow in the dark, photographic dark room equipment can be painted, and so on

Now available under the name of Lumi-Tone Phosphorescent Paints is a material which is easily applied and which, if covered with a protective coating film which is available with the paint, can be used out of doors or in locations where high humidity prevails

● ● ●

FREIGHT—Motor trucks carried 9 percent of the nation's freight moving on wheels in 1940, according to data compiled by the Equitable Life Assurance Society.

● ● ●

BROWN EVERGREENS

May be Due to Natural Causes

The browning or rusting of evergreens, especially arbor-vitae and pine, must be quite general, judging from the numerous inquiries received at the State Experiment Station at Geneva, New York, from home owners who are alarmed over their ornamentals, says Dr. F. L. Gambrell, Station entomologist Generally, the browning of evergreens during the fall is a natural phenomenon and is nature's way of pruning these trees, says this authority

"In the early fall the amount of browning may vary considerably during different years," says Dr. Gambrell, who continues as follows: "Commonly, this condition is quite natural, that is, it is a case of natural shedding or pruning of the older leaves and branches and is comparable to that which occurs on deciduous plants Fall browning is particularly noticeable on arbor-vitae and may also be observed on pines in the form of browning and shedding of the 3- and 4-year-old needles Occasionally, the 2-year-old needles fall, but this may be due to some organic agency or adverse weather conditions."

A browning of evergreens may occur in the early spring and again in the summer, says Dr. Gambrell, and in such cases several factors may be involved, some of which require care to prevent serious injury. If browning occurs in late February and early March, it may be attributed to a drying out while the soil is still frozen and the tree unable to replace the water lost by the needles Exposure to the prevailing winds and direct sunlight generally accounts for this injury which may be reduced by shading or screening the trees wherever this is practical.

Summer browning of evergreens is most generally caused by insects, with the spruce mite as a common source of trouble, especially during hot, dry weather. This insect attacks other types

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The Mechanism of Mind

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of evergreens as well as spruce and can be detected upon close examination as tiny reddish creatures crawling about the trees. Dusting sulfur gives good control. Summer browning may also be due to scale insects, root weevils, spruce gall aphids, unfavorable or poorly drained planting sites, hot, dry weather, or the failure of newly transplanted trees to become established.

INDEX SYSTEM

Uses Plastic Instead of Metal Strips

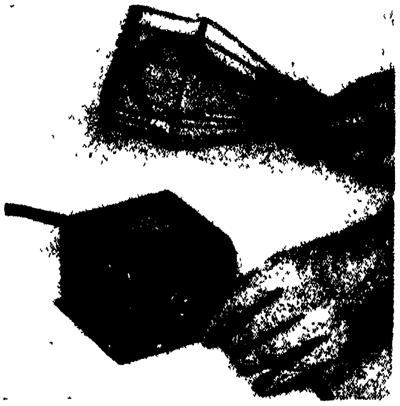
Strips of Tenite are replacing aluminum in the new Visi-Record card index system, and are said to improve its efficiency. The strips are continuously extruded and then cut in lengths to fit the vertical edges of the divider cards. Once snapped and riveted into position, they serve to support the cards and protect their edges against wear and tear from handling. By using different colored strips, indices and sub-divisions of the system can be identified at a glance. The non-resonant quality of Tenite makes for quiet operation.

Colored plastic in file system

LAMP

Operated At Low Voltage Increases Safety

Where electric extension lights are used in the shop and factory, occasional injuries are caused by shock, particularly when such lights are used in wet locations. Such danger can be eliminated by the use of a six-volt bulb in the extension light, supplied with current through a transformer. This arrangement is commercially available in the form of the Ideal Lo-Volt Transformer shown in one of our photographs. The primary lead plugs di-



Low voltage, high safety

rectly into any 110 volt A.C. supply; the secondary lead delivers current at a harmless pressure of six volts which cannot be felt even though it is short-circuited directly through the body.

PROOF?

The Joke was on Bischoff, But Too Late

BISCHOFF, one of the leading anatomists of Europe, thrived some 70 years ago. He carefully measured brain weights, and after many years' accumulation of much data he observed that the average weight of man's brain was 1350 grams, that of a woman only 1250 grams. This at once, he argued, was infallible proof of the mental superiority of men over women. Throughout his life he defended this hypothesis with the conviction of a zealot. Being the true scientist, he specified in his will that his own brain be added to his impressive collection. The postmortem examination elicited the interesting fact that his own brain weighed only 1245 grams.—*Journal of the American Medical Association.*

MOST NOTABLE

Which are the Outstanding Scientific Instruments?

HISTORIANS of the future, we believe, will choose the cyclotron and the electron microscope as the most notable new instruments of the age. Both are remarkable because they contribute to several fields of science. By its massive design and large dimensions, the cyclotron has undoubtedly captured popular imagination; but from a strictly technical point of view it might be argued that the electron microscope is a tool of wider application. Physicists, biologists, engineers, chemists, bacteriologists—all have problems whose solution is almost assured.—*Prof. Thomas H. Osgood in Journal of Applied Physics.*

IMMEDIATE DELIVERY
LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS

	Inlet	Outlet	Price	With A C motor
No 1 Centrifugal	¼"	¼"	$ 6.50	$25.00
No 4 "	¾"	½"	13.50	32.00
No 9 "	1¼"	1 "	16.50	35.00

← GEAR

No 1½	Gear	⅛"	Price $ 9.00	With A.C motor	$25.00
No 2	"	¼"	" 10.00	" " "	27.50
No 3	"	⅜"	" 11.50	" " "	28 50
No 4	"	½"	" 12.50	" " "	32.00
No 7	"	¾"	" 15 00	" " "	37.50
No 9	"	1 "	" 16.50	" " "	49.50
No 11	"	1¼"	" 48.50	" " "	on request

ATTIC AND INDUSTRIAL FANS

Belt driven, slow speed, exceptionally quiet in operation, highly efficient G E Motors

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30"	1/6	540	5800	52.00
36"	1/4	415	8000	57.50
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16"	1750	1800	21 00
16"	1140	1650	27.50
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18"	1140	2100	32.00
20"	1140	2800	36 00
24"	1140	4000	42.00
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Night Vision

A British Army Medical Officer Considers a Subject of Vital Interest to Aviation in Particular

ALEXANDER KLEMIN

Aviation Editor, Scientific American.
Research Professor, Daniel Guggenheim
School of Aeronautics, New York University

TO BE able to see in the dark is quite an important matter to night-fighter pilots, the crews of night bombers, spotters of the anti-aircraft service, drivers of vehicles by night, and others. It will be equally important to civilians as they become Air Raid Wardens. Therefore, we read with great interest an article on night vision, by Captain Brian St.J. Steadman, of the Royal Army Medical Corps, recently published in *The Aeroplane*.

The part of the eye that is sensitive to light is called the retina—the innermost of three coats that form the eye ball. In one of the outer layers of the retina lie two types of cells known as cone cells and rod cells, both distributed over the retina. A complex substance known as visual purple is present in the rod cells, and it has the remarkable property of being bleached on exposure to light but regenerating rapidly in darkness or semi-darkness. Now here, in Doctor Steadman's words, is the explanation of night vision:

"Vision depends on two mechanisms. One, governed by the cone cells, is concerned with form vision and color vision and functions only in bright light. This is known as the photopic mechanism. The other depends on the rod cells and the presence in them of visual purple. It is concerned with appreciation of light and movement and functions in conditions of semi-darkness. This is known as the scotopic mechanism. Everybody knows that after going from bright light into semi-darkness one can see very little at first, but that after an interval one begins to see more clearly. This is due to an increase in sensitivity of the rod cells caused by the regeneration of visual purple and is known as dark adaptation."

This dark adaptation increases rapidly after we are plunged in darkness or semi-darkness. At the end of one hour the sensitivity of the retina may be increased between 50,000 and 100,000 times.

What should be done to increase the night vision of those about to engage in the specific tasks we have mentioned? First of all, they should wear dark goggles or stay in a completely dark room for 45 minutes. To test whether one's eyes are dark adapted, a star should be looked at directly, and then the line of vision should be deviated slightly. If the star appears brighter in the second case, then the faculty of night vision is in full use. The reason for this is that there are no rod cells in the retina at the central point, that part used for clear vision during the day.

The quality of night vision varies in individuals and some people suffer from night blindness, which may be caused by a deficiency of visual purple, due, in turn, to a deficiency of vitamin A in the diet. Night blindness may be cured by eating liver, carrots, and so on. But, unfortunately, no amount of food containing vitamin A will improve any lack of night vision faculty that a person may have. Dr. Steadman explains it this way: "Experiments have shown that it is useless for people with a poor night vision standard to attempt to bring about an improvement by eating two pounds of raw carrots a day."

Since selected food is no cure, the best that the British have been able to do for their night-fighter pilots is to devise tests for the standard of night vision and to give selected candidates a course of exercises. The quality of night vision may be improved by constant practice With eyes fully dark adapted, an endeavor should be made to recognize at night the outlines of trees and buildings against the sky, both with and without field glasses. Commencing with familiar outlines, the distance may be gradually increased and use made of unfamiliar outlines. Large letters or diagrams of aircraft may also be employed. The amount of training done in this way, and its helpfulness, is determined by the individual himself and depends largely on his keenness.

SHOP LIGHTING

Fluorescent Tube Used in Portable Unit

WITH all the good will in the world, our aviation notes seem to drift away from the progress of aviation science to the progress of aviation manufacture. One reason is that the most important scientific advances in aeronautics are apt to go on the secret list, to discuss which means the risk of dire penalties. Another reason is that emphasis today is on production and practical advance rather than on radical development.

Thus we can and should devote attention to the use of a portable fluorescent light for night work in the aircraft plant. The new light is encased in a tube of transparent "Lucite," methyl methacrylate resin. The light is of low weight, handy, and gives off spherical lighting so that shadows are eliminated. It is cool, which is a real advantage One of our photographs shows a foreman using the light while working on a Lockheed P-38.—*A. K.*

It brightens the corners

"HAPPY" SPEAKS

And Tells Something of the Army Air Corps

The first Chief of the Army Air Force, Major General H H. Arnold, is frequently spoken of as "Happy Arnold," but his character and energy are such that the nickname does not fully become him General Arnold, a veteran flier with a thorough knowledge of every phase of military aviation, is just the man we need today when aviation is all-important in our war plans. His resumé of Air Corps developments for the last year or so is significant and encouraging.

Fighters are the best defense against air attack, but bombers alone can lead to victory. "The heavy bomber," says General Arnold, "in which type we lead the world by several laps, remains the backbone of air power" We need only recall the Boeing Flying Fortresses to agree with the General. With their pressurized cabins and supercharged engines the Boeings can operate at over 40,000 feet altitude where they are, for the moment, immune to attack by pursuits or anti-aircraft guns. The fighter, with

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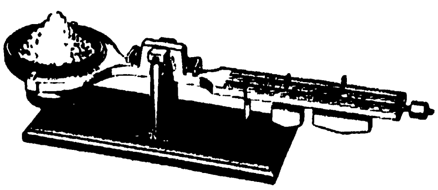

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its superior maneuverability, can outfight the bomber, but its ceiling will have to be boosted. Dive bombers have become synonomous in the public mind with German aviation; but as a matter of fact it was the United States Navy which first introduced dive bombing and it is the Curtiss-Wright Corporation which has built the world's best dive bomber.

Another achievement of the Army Air Corps lies in its ferrying program. The Air Corps Ferrying Command takes planes, with rare accidents, from the West to the East Coasts, from the East Coast to Greenland, to Iceland, to Georgetown in British Guiana. Here is what the General says: "Except for our short-range planes, the Air Corps Ferrying Command is capable of operating around the world. Its navigators are studying globes, not maps, and they would take a bomber to Tibet or Little America on 48 hours notice."

Since Crete, there has been a general feeling that glider-born troops have proved their value. The Air Corps is keeping step with this new development also by the procurement of gliders and by training pilots in gliding and soaring. Army and Navy alike are interested in the towed glider capable of transporting many armed men Altogether, General Arnold's message is very encouraging. It shows that our Air Corps is wide awake, following every air development of the war.—*A. K.*

TELESCOPE MAKING?

Doctor Urges Pilots to Take Up Hobbies

TODAY'S high and fast flying pilots will take up stamp collecting, gadget making, or the study of foreign languages if they listen to the advice of Mayo Clinic's Dr M. N. Walsh.

The modern pilot's nerve-splitting profession not only requires that he groom his body like Joe Louis, but that he save every possible milligram of his nervous energy by learning how to relax, Dr. Walsh declares. To combat excess drain on nervous energy, he urges perfect physical condition aided by frequent rest periods and hobbies. "The importance of hobbies in securing mental relaxation is much underestimated. The chief value of hobbies . . . lies in their capacity to release pent-up nervous tension. The most satisfactory hobbies are those which involve making something with the hands or forming collections, so that the individual can enjoy the feeling that he has created something worth having, and can spend a quiet and restful hour with his hobby in forgetfulness of the worries of his daily occupation."—*Science Service.*

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

"DISTILLED" WATER

Obtained By Process Using No Heat

WHERE industrial operations require the use of pure water for any of a number of purposes, distilled water is usually used. For such operations it is now possible to obtain pure water comparable to single distilled water without the use of heat and at a small fraction of the cost of distilled water.

This "synthetic distilled water," as it is called by the Illinois Water Treatment Company, manufacturers of the equipment which produces it, may be obtained with as low as four parts per million of dissolved solids.

Complete heatless water "still"

The treatment process uses equipment which passes the water successively through two beds of special minerals, the first of which removes, by base exchange, the positive, or metallic ions, such as calcium, magnesium, sodium, or iron, substituting hydrogen The effluent from this tank is acidic in that the hydrogen ion combines with the negative sulfate, chloride, and nitrate ions. (The carbonates form H_2CO_3 which passes on through as CO_2 and water, and the CO_2 can be very largely dispelled by aeration if its presence is undesirable)

This acid water passes to an anionic reactor tank where the negative ions (chlorides, sulfates, and nitrates) are removed and replaced by the hydroxyl ion The H and OH combine to form water, giving a final effluent which compares very favorably to commercial single distilled water.

The equipment has both an hourly capacity or flow rate in gallons per hour and an overall capacity when the minerals become exhausted and are regenerated similarly to a water softener. The chemicals used in regeneration are commercial acid and soda ash which are cheap and readily obtainable.

It is stated that this "synthetic distilled water" is already being used in many industries where processes call for extremely pure water In other industries the low cost of "distillation" makes it possible to take advantage of this purity where cost was formerly so high as to be prohibitive.

JACK

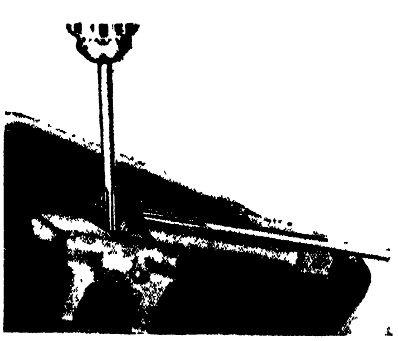
Wedge Blocks For Leveling Machines

A SIMPLE arrangement of two iron castings and a shouldered screw, placed under a machine, makes it possible to level the equipment quickly and accurately. The two iron castings are wedge shaped, the head of the screw bearing against a slot in the lower casting. As the head of the screw is turned, it forces the upper casting to slide on the lower one, thus increasing or decreasing the height of the assembly and hence making it possible to bring the machinery to exact level. The device, manufactured by Enterprise Machine Parts, is known as a "Machine Jack."

REAMER

Operates in Hardest Steels

A NEW type of reamer, made of Hardsteel and capable of reaming hardened steel of any degree of hardness



Reamers described above can be used even on hard steel drill stock

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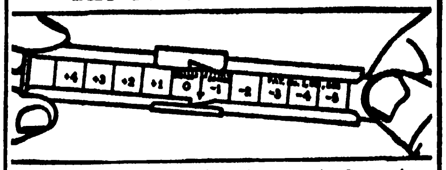
The Morse Decimalizer



The DECIMALIZER shows in a few simple manipulations just where to place the decimal point in the result of any computation involving several elements, part or all of which may be decimals for example, in such a problem as (9 x 0442 x 74 1 x 3 8) ÷ (245 x 0093 x 36) The DECIMALIZER removes that "decimal point hazard" inherent in computations made with the slide rule or otherwise

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without annealing, has been developed by the Black Drill Company. The reamer, made of the same secret-process metal which is used in Hardsteel drills, [See page 93, February 1942 Scientific American.—Ed.], is designed to operate in the same manner as the drills and, it is claimed, will easily outlast any high-speed reamer now in use. While the ordinary high-speed reamer will ream metals up to 35 degrees Rockwell, Hardsteel reamers will ream metal of any hardness up to and including nitrided surfaces, without unusual wear. They have been used successfully on carburized, oil hardened, water hardened, cyanided and nitrided pieces of high carbon, high chrome, and high-speed steel.

The accompanying illustration graphically shows the possibilities of Hardsteel reamers. A hole drilled by a Hardsteel drill in a twist drill, with a Rockwell 60 C., is being reamed without effect on the reamer.

ACID INDICATOR

Used in Controlling Industrial Process

INDICATIVE of the possibilities of the solu-bridge controller for industrial purposes is the recent application of this unit, manufactured by Industrial Instruments, Inc., to the processing of mineral oil. Mineral oil is treated with concentrated sulfuric acid in large vats. At the end of the treatment cycle the concentrated acid which has not entered into reaction settles to the bottom of the vat. Above this there is sludge, with treated oil above the sludge. The sulfuric acid is first drawn off from the bottom of the vat, followed by the sludge, and finally the treated oil comes through The conventional method of ascertaining when all the acid and sludge have been removed is by means of a by-pass pipe and visual observation. The operator at times does not notice when the withdrawal of sludge has ended and treated oil starts coming through.

When the problem was first put up to the industrial instrumentation engineers, their first step was to check liquids withdrawn from the vat by means of the solu-bridge. It was found that sulfuric acid read over 7 percent, the sludge approximately 0.2 percent, and the treated oil gave a reading of 0. Thus by placing a special conductivity cell in the by-pass line, and setting the indicator of a solu-bridge controller at 7 percent, the self-contained relay of the instrument closes and actuates an alarm when sludge begins to come through. Again, setting the indicator at 0.01 percent, the relay will close and give indication when oil starts to come through.

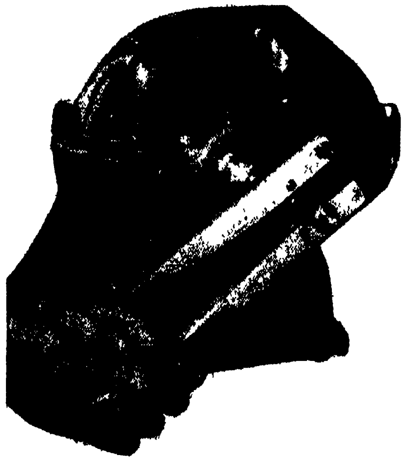
The solu-bridge controller is an electronic device which not only indicates the conductivity of a given liquid in any desired terms, but also, by means of its self-contained relay, actuates an external warning signal such as a flashing lamp or audible alarm. The relay can also be employed to control some suitable corrective means, such as opening or closing solenoid-actuated valves.

KNURLING

Plier-Type Tool Is Adjustable

KNURLED surfaces can be produced on metal rods having diameters between $\frac{5}{16}$ of an inch and two inches with a new adjustable plier-type knurling tool announced by the Pacific Specialty Supply Company.

Two knurling wheels are mounted on one arm of the tool and a third on a hinged arm which can be adjusted by means of a removable hinge pin. In use, the tool with its three knurling wheels is placed over the work and pressure is applied by hand to close the wheels against the work surface. The work can be rotated by any means as in a lathe or drilling machine, or it can be held in a vice and the tool revolved around it.



Hand knurling on a lathe

NOZZLE INSERT

Of Ceramic, for Air Blasting Equipment

AN extremely hard, abrasion-resisting ceramic, now being used instead of metal for the inserts of "Long-Lyfe" abrasive blast nozzles manufactured by American Foundry Equipment Company, is claimed to have a hardness and density that is superior to many of the metals now being used for this purpose. Its manufacture is not affected by the present scarcity of certain alloys.

Economy of operation is achieved with these inserts because the cost of compressed air is kept at an absolute minimum since the nozzle wears slowly and evenly. Also, because the original orifice is preserved without appreciable wear, even after hundreds of hours of service, the contour of the blast stream is maintained and the work is cleaned faster and more uniformly.

Additional features of this nozzle include: High finish bore; no soft spots to start uneven wear; non-metallic, thus reducing static to a minimum; does not "bell out" rapidly; excellent mechanical strength.

SWITCH

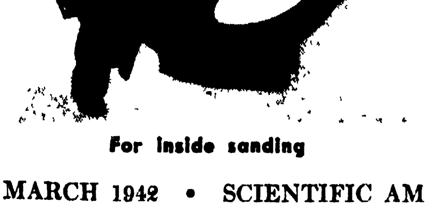
Foot Operated For Start-Stop Operation

A foot-operated switch which solves many problems of frequent start-and-stop operations of machines, incorporates tungsten contacts which are held in open position by spring pressure but are brought together to close a single-pole circuit when pressure is applied to the top of the rubber housing of the switch The switch responds to the slightest down pressure of the foot; it is claimed that less pressure is required than is applied to the average automobile accelerator. Rated at 1000 watts, these switches have a conservative guarantee, by the Nathan R. Smith Manufacturing Company, for 40,000 operations per year. They can be used to control the operation of any small machinery within the rating range.

SANDING

Machine For Use On Inner Surfaces

For use in production work which requires sanding of the inner surfaces of wood grilles and other shapes, a unit machine has recently been developed by the J M. Nash Company. Built into this machine is an adjustable chair for the operator and an adjustable foot pedal which controls the tension of the continuous sanding belt.



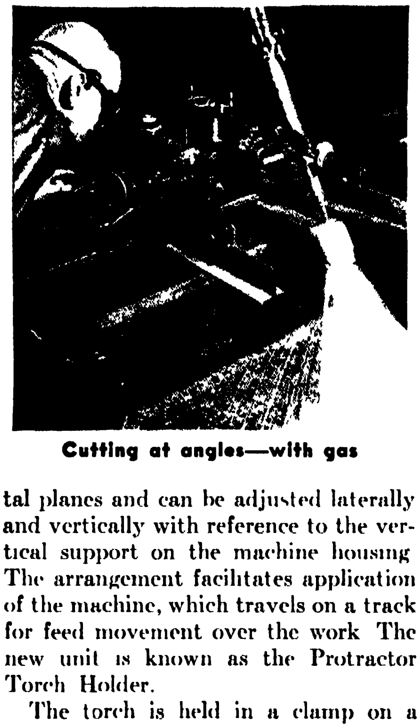
For inside sanding

One of our photographs shows this sanding machine in use. The operator can apply the work to either the upper or lower surfaces of the belt. When he finishes with one interior opening, it is only necessary to depress the foot pedal, whereupon the belt action stops and the belt can be released from the pulley nearest the operator. The work piece is then removed from the belt, the belt is introduced into another opening to be sanded and then slipped back on the pulley Releasing the foot pedal tightens the belt and starts it in motion.

GAS CUTTING

Torch Holder Is Adjustable

A new torch holder has been developed for the Radiagraph gas cutting machine by which the torch can be set at any angle in vertical and horizontal planes and can be adjusted laterally and vertically with reference to the vertical support on the machine housing The arrangement facilitates application of the machine, which travels on a track for feed movement over the work The new unit is known as the Protractor Torch Holder.



Cutting at angles—with gas

The torch is held in a clamp on a spindle secured at right angles with a supporting arm The arm rotates on a horizontal support at the end of a slide riding in a bracket. The bracket mounts on a vertical post on the machine housing The spindle rotates and clamps at a desired angle and is set with the aid of a protractor in the spindle assembly. The arm and the end of the slide also are graduated for rotation of the former to an angle and are clamped in set position. The bracket moves the arm up or down when a crank is turned, in or out when a handwheel is operated.

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CAMERA ANGLES

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Stroboscopic Multiflash

STROBOSCOPIC multiflash photography is the term used by Gjon Mili, engineer-photographer, to describe the method of making such pictures as those reproduced here. To the already familiar method of multiflash, which involves the use of several flash sources to make a single picture, Mr. Mili adds multiple exposure for recording several images on the same plate.

Mr. Mili, who recently exhibited 50 prints at The Museum of Modern Art in New York City, in the first showing of his stroboscopic flash work ever held, sees in stroboscopic multiflash the nearest approach to what he considers a faithful method of photographing dancers in action.

"The dance is an expression in time and space," he says. "Accordingly, in making a record of the dance, in order to retain its quality, a motion-picture camera should be employed. A single photograph, however fortunate its composition or its expression of feeling, can at best suggest only the mood without indicating the line of movement or the phrasing. In order to record an entire movement on a single plate, use was made of the technique already known as stroboscopic multiflash photography."

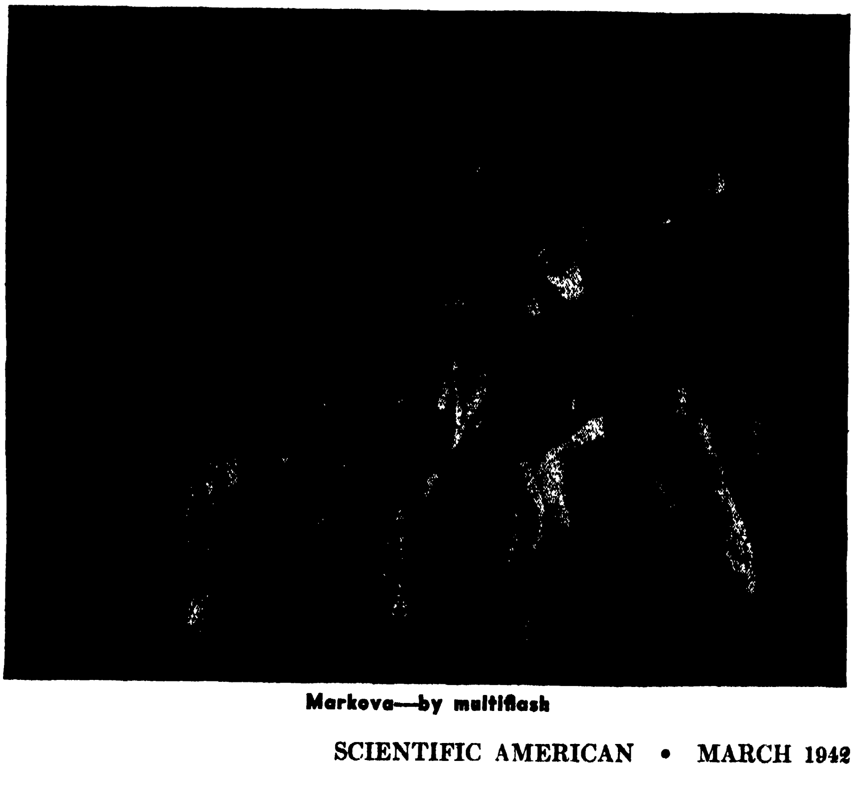
Employing a 5 by 7 Deardorff studio-type view camera, Mr. Mili describes his procedure as follows:

"The camera is held open throughout the period of a phase while lights equipped with Edgerton high-speed tubes are flashed repeatedly—in order to impress a multiplicity of images on the same plate. The pattern can be changed at will by altering the rapidity of the flashing—by accelerating or retarding it; it is this controllable multiflash element which can make possible a truly artistic presentation of dance movement.

"Dance in Movement"

"The majority of the patterns exhibited were achieved with the aid of three lights which flashed at intervals from 3 to 15 flashes a second, depending on the speed of the movement. The camera was operated at aperture stops ranging from f/5.6 to f/16."

The results achieved have both pictorial and scientific appeal, sometimes in combination, sometimes one or the other. Rapidity of movement is the first requirement, beauty of movement secondary, but essential if pictorial appeal rather than pure fact-finding is the result desired. Because of the extreme speed


Markova—by multiflash

of the light, a fuzzy image is hardly possible; only poor focusing will cause lack of sharpness.

In the single stop-action photographs included in the show, when 3 to 12 single flash Edgerton units were employed, Mr. Mili tried to catch the dancer at the very height of an intricate whirl or leap. In the case of the stroboscopic multiflash photographs, however, he attempted to show a complete sequence of movement that included not only the most dramatic split-instant action but the series of split-instant actions that preceded and followed the "main event" In other words, his multiflash shots are the still-picture approximation of the motion-picture record.

Thus, he shows the accordion-like multiple movements of a dancer, or the spider-web filaments of a human cartwheel split into segments as it flashes through space.

For Minimum Blow-ups

In making tests of a new fine-grain developer, the painstaking worker will try "blowing" the negative as far as it will go short of the image falling apart. But what good does that do if, holding onto small grain size, the image actually melts away as to quality? More reasonable would it be to enlarge the negative, or a reasonable portion of it, to the 8 by 10 or 11 by 14 print you normally require. If the result is good after this test, you should be satisfied; if it is poor, then you may abandon this particular "soup" and try another or give the first a further chance by checking back on yourself to see if you followed the manufacturer's instructions and recommendations as to time, temperature, and so on.

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What's New

In Photographic Equipment

Kodak All-Metal Printer Model 2 ($19.75): Takes negatives from 35mm to 4 by 5½ inches. Has four adjustable, inch-wide, margin masks Permits strip printing of many popular sized roll films; provision for introduction of printing controls such as ground or opal glass. Measures 10 by 8 by 6 inches Includes as supplementary feature ruby Kodaloid scales illuminated from below by printer's ruby safelight White etched scales easily read.

Kodak Testing Outfit for Acid Rinse and Fixing Baths for Paper ($1): Compact, two-bottle kit, one for acid rinse, the other for fixing bath.

General Electric Blackout Flash Bulbs: Small bulb called G.E. "mighty midget" blackout photoflash lamp No. 5-R, identical in size and shape with Mazda "mighty midget" No. 5. Large blackout flashbulb, identical in size and shape with G E Mazda No. 21 photo flash lamp, known as G.E. blackout photo flash lamp No. 22-R. Bulbs have special purplish-black coating, whose characteristic is ability to screen out visible light, yet letting through the infrared. Lamps are used in conjunction with infra-red film.

"Japs Bomb U.S A.!": Movie depicting historic surprise attack by Japan upon Hawaii and incidents that led America into war, made available by Castle Films in five sizes and lengths, three 16mm editions, two 8mm editions.

Blue Mighty Midget No 5: "Peanut" photoflash now available with blue coating for use in color photography. Color coating has same characteristics as that of G.E. No. 21B, matched by Eastman to color characteristics of daylight type Kodachrome.

Solar Mercury Tri-Switch ($5.50): For use with double contact socket and double filament bulbs to provide selective lighting in projection printing. Light intensities adjustable for 50, 100, or 150 watts in accordance with density of negative Designed for tabletop use Single throw, double pole type, with levers operating the mercury contacts.

Bayley Cine Color Kit ($6.50): Contains neutral density polarizing filter; Type A filter to convert indoor Kodachrome for outdoor use; Kodachrome haze filter to absorb ultra-violet rays. Filters housed in leather kit, which also includes all-metal sunshade and filter holder combination. Kit fits practically all 8mm and some 16mm movie cameras

Willoughby Exposure Record Book (25 cents): Contains printed forms listing various data in connection with exposure and processing, gummed for pasting on negative envelopes. Offered as convenient method of keeping exact records

John-Bayley Neutral Density Polarizing Filters: Made of precision ground optical glass to darken skies and eliminate glare and reflection, specially recommended by manufacturers for use in color photography Available in all sizes; those fitting Series V and VI in the Eastman Kodak series list at $2.90 and $3 40, respectively.

Eastman Electric X-Ray Timer ($15): For use in processing X-ray films. Designed for timing in ¼-minute intervals for periods up to 10 minutes. Six-inch translucent Tenite dial with opaque markings read in silhouette; dial illuminated from within like safelight. Convex glass protects dial and hands of timer All controls on top. Repeat timing. Operates only on 60-cycle 105 to 120-volt A. C Housed in case of die-cast metal, finished in smooth dark-grey enamel. Included is 48-inch rubber-covered electric cord, with plug

8mm Rental Service: Initial listing of 75 subjects consisting of features, cartoons, sport shorts, travel subjects, musicals, and novelties, announced in Bell & Howell's 1942 edition of catalogue of recreational films.

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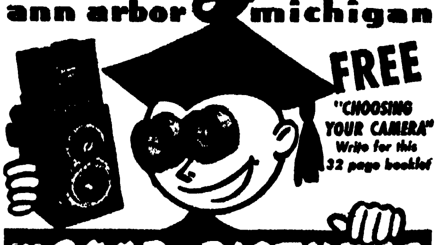

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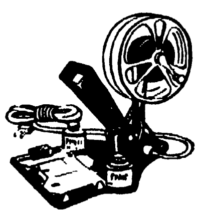

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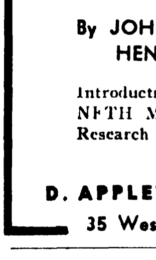

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For a long time, this department has sought opportunity to reprint and thus make available to the average amateur a lengthy paper on the tests of the 82" mirror at the McDonald Observatory in Texas, written by Dr. J. S. Plaskett, late Director of the Dominion Astrophysical Observatory in Canada, originally published as *Contributions from the McDonald Observatory, University of Texas*, No. 1, later in *The Astrophysical Journal*, Vol 89. The astronomer Plaskett was also an optician, acting as advisor on a number of large mirror jobs and as final acceptance tester for purchasing institutions.

The amateur who studies this paper will follow the tests exactly as the professional sees and makes them and will discover no mysteries but mainly the same things he does on smaller mirrors, and some of the same old headaches. Perusal should flatter his vanity, also confirming him in his methods.

One professional astronomer, director of a new observatory, asked this department to suggest the names of men qualified to make the acceptance tests on a very large mirror Dr. Plaskett was of course named, as were others; and then A. W. Everest and other advanced amateurs were suggested The astronomer had had the same thought—for many amateurs do more mirror testing than any professional, and in this way become highly expert in the eye-detection and interpretation of shadow subtleties. It turned out that the chief practical problem was not about the amateurs *per se*, but the university's trustees: "What would *they* say if I nominated amateurs! They'd never understand. I'd never live it down." We suspect he was right. The word "amateur" has two connotations

Dr Plaskett's article, which will require close study, follows:

The Warner and Swasey Company, who have designed and constructed the mechanical parts of the Lick, Yerkes, Victoria, and other large telescopes, have never undertaken, until the contract for the McDonald Observatory was signed in 1933, to supply the optical parts for their instruments. The deaths of Dr. Brashear and Mr. McDowell, who had in recent years provided the optical parts required, and the desire to make the complete telescope, were probably the main reasons inducing this famous firm of telescope-builders to include an optical department in their organization. This was established in 1933 under the direction of Mr. C A. R. Lundin, who had previously acted as chief optician for the well-known firm of Alvan Clark and Sons

The optical shop was fitted with a grinding and polishing machine for the 82" mirror and with a smaller machine for a 57½" flat to be used in testing the 82". Work on the latter and on some smaller jobs occupied the time until the arrival of the 82" disk from Corning in October, 1934 Grinding was commenced on October 19, 1934; and nearly four years later the mirror was completed, on October 14, 1938. The figuring was not, however, continuous throughout the period, as in the hope of early completion the figuring with the full-sized tool was unfortunately continued so far that, early in 1937, the focal length became too short. Even though the parabolizing was nearly completed and the reduced focal length was within the range of adjustment provided in the mounting, neither the firm nor Mr. Lundin was willing to allow such a departure from the specifications It required several months' work with the large tool to flatten the curve sufficiently, so that the final figuring— for the earlier close approach to the paraboloid was wiped out in the flattening process—did not begin until October, 1937 Twelve months can hardly be considered an unduly long time to figure an optical surface of this size in a newly established shop.

Early in 1936 I was asked by the Warner & Swasey Company to act as consultant in optical and other scientific matters connected with their instrument work, and in 1937 I visited Cleveland twice- once in May during the flattening process and later, in October, after the commencement of the refiguring. I was summoned again in March, 1938 when it seemed desirable to make a change in methods and remained, with two intermissions, consulting with Mr. Lundin until the mirror was completed on October 14.

During a visit, late in March, of Dr. Struve, the director of the new observatory, and two associates Dr. Van Biesbroeck and Dr. Kuiper—a different method of testing was proposed, depending on measurements at the center of curvature from which a "curve of shape" was developed, the purpose of which was to give the true form of the surface with exact numerical values of the deviations from the paraboloid. The results from this method, which was extensively used and which will be more fully discussed later, were, however, at first disappointing; and early in May the 57½" flat, which had been given a very fine figure by Mr. Lundin a year earlier, was silvered and thereafter was used as the principal means of testing the surface of the 82" mirror

It may safely be said that, after the flat was set up and the shadow pattern at the focus could be observed-- the method which Mr. Lundin had always hitherto used in figuring mirrors—the

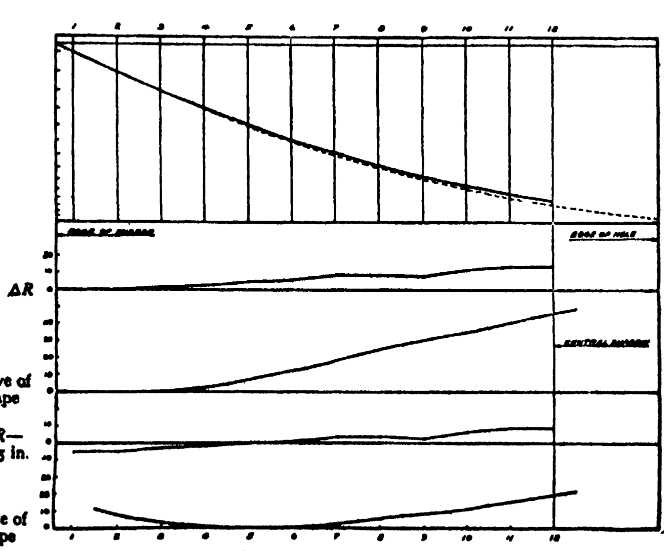

Figure 1: Curves of October 5, 1938

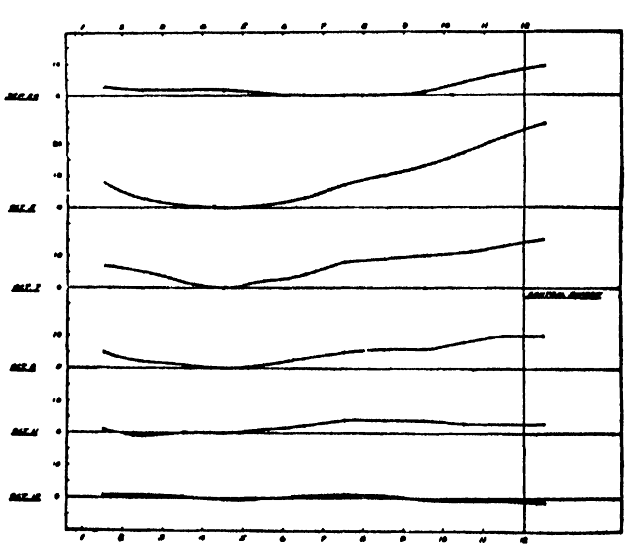

Figure 2: Curves of shape, 82" mirror

progress toward the final result was steady, if not quite continuous. As is probably the case with all optical work, especially large surfaces, various difficulties and occasional setbacks were encountered It may be sufficient to mention first a sharply turned-up edge—much preferable, however, to one turned down—which required considerable handwork with small tools to reduce, at which Mr. Lundin is remarkably expert A second difficulty was irregularity and lack of general smoothness over the surface, a problem completely solved by substituting for the full-sized tool a half-sized tool, with a long sweeping stroke.

The final figure came quite rapidly at the last, as can be seen in the graphs in Figure 2, where the units are millionths of an inch and where the curves of shape of September 24, when the half-sized tool had barely come into use, and those of the final week of figuring are given Dr. Struve and Mr Fred Pearson, of the University of Chicago, paid a visit of inspection on October 6, when, under the knife-edge test at the focus, the figure looked so smooth and uniform that they adjudged it as nearly finished. However, tests at the center of curvature next morning and formation of the curve of shape showed it as still undercorrected to the extent of 20 millionths of an inch, a whole wave, and work was continued. Progress on one day enabled an estimate of the required time of polishing to be accurately made, and on this basis the paraboloid was considered completed on October 12, when the curve of shape showed deviations only slightly larger than a millionth of an inch, an eighteenth of a wave. Tests at the focus showed a high central zone, which Mr. Lundin reduced to practical invisibility in four short hand workings on October 12 and 13 The mirror was inspected and accepted by Dr. Struve on October 15 and was then made ready for aluminizing, necessary to make the Hartmann test and to figure the secondaries. The mirror was taken out of the vacuum chamber on October 24 and set up in the optical shop, where the visual and photographic tests were completed.

The method of testing the surface was a modification of the well-known method of determining the center of curvature of a number of zones spaced uniformly over the surface and comparing these measured positions with those computed from the properties of the parabola. A cardboard diaphragm was placed in front of the mirror, containing 28 circular 1.5" holes, spaced uniformly along a horizontal diameter at a separation of 2.5". The innermost zone, No. 14, has a radius of 7.75"; and the outermost, No. 1, of 40.25". A series of shutters before the openings, manipulated by a rod extending through a partition, enabled the zones to be opened at will without going near the mirror. The intersection of the converging pencils from a fixed artificial star was determined at first by an eyepiece and later, more accurately, by a knife-edge. Obviously, in this case, the departures of the intersections from the computed posi-

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tions are double those of the radii of curvature and four times those at the principal focus.

The knife-edge is attached to a slide moved parallel to the optical axis by a screw, the positions of intersection being obtained by lines scribed against a straight-edge on a stationary aluminum plate, rigidly attached at right angles to the slide. The positions of the intersections were either directly compared with a standard series in the computed positions, or later, as the mirror approached completion, the separations of the scratches were accurately measured by dividers on a steel scale. A modification developed by Mr. Burrell consisted in plotting the positions of the zonal openings as abscissae and the distances of the corresponding intersections from that at the center of the mirror as ordinates. The method is illustrated in the upper part of Figure 1, containing the measures of October 5, plotted as a curve which can be directly compared with a normal parabolic curve drawn in a dotted line through the computed positions. Blueprints were made of the fixed parts of this diagram, and the observed curve could be rapidly laid down on one of these prints from the scratches on the plate, the positions of longer radius being above and of shorter radius below the standard curve. The curve was at first considered as indicating where glass should be removed instead of showing where the surface was too flat or too concave.

It was the purpose of the curve of shape proposed by Dr. Struve, Dr. Van Biesbroeck, and Dr. Kuiper to overcome this difficulty and to represent graphically the actual form of the surface and the exact deviations from the paraboloid. The method is simple, the tilt of the element of the surface 2.5" wide, centered on any zonal aperture, being determined from the deviation of the intersection of the corresponding pencils from the computed position. The departure of the ends of this element from the paraboloid is thus obtained; and joining these ends together—in other words, alegebraically summing the departures consecutively across the surface—gives its true form, the factors being so chosen that the departures of the intersections from normal, hereinafter called *R*, in hundredths of an inch, correspond to millionths on the curve of shape and on the surface.

Unfortunately, this method is also subject to ambiguity, particularly at the edge of the mirror, as the curve only begins to give reliable information halfway between zones 1 and 2; furthermore, the general slope depends upon the choice of zero, or the starting-point of the measures. This latter point is illustrated in the central part of Figure 1 in the measures of October 5. The deviations of the intersections plotted at the top of the figure with respect to the parabolic curve are repeated directly below, but on a different scale, in the broken curve drawn with respect to a straight-line base. These deviations, in hundredths of an inch, are transformed into the smooth curve of shape immediately below, showing deviations from the paraboloid in millionths of an inch. In the lower pair of curves the broken curve is exactly the same as above, except that 0.05" is subtracted from each measure, or the base line is lowered by 0.05". The curve of shape, however, is quite different, as not only is the slope radically different, indicating an alternative method of reaching a parabola of slightly different focus by removing glass both at edge and center instead of the center only, but also the average curvature is changed. Notwithstanding these difficulties, which rapidly diminish as the paraboloid is approached, the method is of distinct value in representing the exact form of the surface and in giving numerical values of the departure from the theoretical curve.

As soon as shadow tests at the focus were available, early in May, they were used exclusively as a guide for the next working, as there was then no chance of ambiguity in the readings and the high zones could be accurately located and marked. The knife-edge shadow tests were supplemented and confirmed by the use of a Ronchi plate, where the condition of the surface was shown by the straightness and parallelism of the resultant bands. Measures at the center of curvature were transformed into curves of shape for Dr. Struve about once a week as a numerical record of progress until toward the end of the parabolizing, when it was felt desirable to check the shadow readings by measures at the center of curvature and by the formation of the curve of shape. For the last ten days or so, this was done after every polishing, as, although the shadow test recognizes very minute departures from regularity of figure, it is perhaps not so sensitive to very gradual changes such as those due to slight under- or overcorrection

This was especially true in this instance, where the flat was a little over two thirds the size of the 82", of which, hence, only a little over half, or just beyond the central hole, could be seen, and consequently the exact position of the knife-edge, its exact focusing, was uncertain, with resultant effect on the shadow pattern. As a result, though the shadow test was essential throughout to insure smoothness and regularity of figure and to determine where polishing was required, the final check on complete parabolization depended upon careful measures at the center of curvature and the resultant curve of shape These were of great value during the last week of figuring, where the proper length of time for the next polishing was determined solely from past changes in the curve of shape. Thus, on October 11 (see Figure 2) the time required to complete the parabolizing, 1¼ hours, was gaged correctly, as seen in the lowest curve, from the change produced by the two previous workings. And here again, the shadow test was essential, for otherwise the high central zone, which had no effect on the measures at the center of curvature, would have escaped notice.

(To be concluded.)

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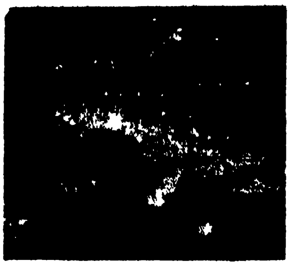

INTEGRAL part of California's Central Valley Project, described in detail on page 178, is Friant Dam, shown under construction in the reproduction on our front cover of a spectacular photograph taken at night under floodlights.

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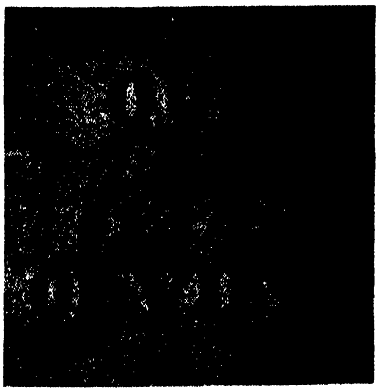
BENEFITS OF WAR

In no sense questioning General Sherman's terse and forever accurate summation that "War is hell," and with not the slightest Pollyannish inclination, we nevertheless point out that the present world-wide conflict of blood carries along with it an educationally constructive phase that will benefit immeasurably every citizen of this country. For the first time in history the men, women, and children behind the men behind the guns *must* learn how to take care of themselves and each other when under fire—just as the soldier, the sailor, the marine must do in the course of his training.

More than five million men and women in civilian life—and the number grows every day—are attending classes, clinics, and demonstrations to master the intricacies of first-aid and nursing, the science of fire-fighting, the mechanics of road repairs and demolition of dangerously damaged buildings, the chemical knowledge necessary for use in the decontamination corps, the mechanics and dangers of unexploded bombs and delayed-action fuses, the manipulation of emergency telephone switchboards, telegraph keys, radio equipment, and many, many other things which most of us have never before felt it necessary to know. Thousands of women, heretofore completely competent to drive automobiles, are breaking manicured fingernails and acquiring "grease-monkey" hands in finding out what motivates their cars, how to make emergency repairs. Business men from every walk of life feel physically better because of the regular exercises incident to walking the beats and engaging in other physical aspects of the training of the air raid warden, the auxiliary fireman and policeman

The enormous scope of this sudden national hunger for knowledge of "how to do it"—particularly since Pearl Harbor—is somewhat difficult to grasp. Indicative of its magnitude, Boston called for 400 volunteer firemen, found 1200 on hand for the first drill; New York City has graduated 20,000 volunteer "smoke-eaters" from an intensive 15-week course; Chicago's police force is recruiting 7000 members from 221 American Legion Posts to be trained as emergency police; more than a million Legionnaires have just been assigned by President Roosevelt the job of organizing and conducting—mostly at the Legion's expense—"schools for the training of personnel for the protective services in the Citizens' Defense Corps of Civilian Defense;" due to the unprecedented rush of men and women to acquire first-aid and other civilian medical information and training, the first-aid text book of the American Red Cross has been at a premium in many communities for weeks.

Where will all this lead us? What will be the effect on a nation of people who, equipped with knowledge gained the hard way—and it isn't easy, after the day's work is done, to devote four to ten hours a week to schooling—will know exactly what emergency treatment to apply in case of a highway accident? Will it not be constructive for thousands of industrial workers, as well as men and women in all branches of industry and civil life, to be familiar with the technique of resuscitation in accidents involving electrical shock, inhalation of gas, drowning, and so on? Can we not hope to become a nation of better automobile drivers, from the dual standpoints of safety and economy, if we understand more of the "whys" and "wherefors" of the "innards" of our cars? What of the benefits to be derived from a broader and more intimate knowledge of foods and their nutritive values, of general health and sanitation, of waste prevention and salvage?



The cumulative answer to these and similar questions—despite the long, hard road of war and its destructiveness and sacrifice—is the unqualified statement that we *shall* be a better nation, a vastly improved people. Still in hearty accord with General Sherman, we contend that the constructive forces at work today, on a hitherto unheard-of magnitude, will be productive of wide-spread benefit and welfare As the war progresses, we shall learn—if we have not already found out—that the job of protecting our ways of life from totalitarian encroachment cannot be done with one hand while the other retains a golf club, a tennis racquet, a fishing rod, or a highball—and that doesn't mean we must deny ourselves recreation. To the contrary, now, more than ever, we need recreation to offset the additional stress of personal war efforts But it does mean that we're faced with a two-fisted job that must be done in typical two-fisted American manner, that each individual, efficiently to perform his share, must make of himself a better executive for the accomplishment of his normal business, social, and recreative life, as well as his extra-curricular defense activities.

There can be no doubt but that the forces emanating from efforts of civilians to fit themselves into a nation and a world at war have constructive characteristics. There can be no doubt but that the concurrent attempts of fifty million or more men, women, and youngsters to find the answer to their question, "How can I help?" will, at first, produce a certain amount of chaos, many uncomfortable growing pains. But, as stated in these columns before, it is an absolute certainty that the people of this democracy are organizing, are building, and will maintain the greatest civilian war effort ever known—and they're being amazingly constructive about it.—*A. D. R., IV.*

FOR THE RECORD

Severe criticism has been leveled, in some quarters, against certain publications for the printing of information and illustrations that, allegedly, may have been of some value to the enemy. As to the truth of this claim insofar as it applies to each and every individual magazine and newspaper in the country, we are not in a position to speak with authority, but we question whether any reputable publication has knowingly violated the code of honor voluntarily assumed by most editorial desks long before hostile action against the United States.

So far as Scientific American is concerned, no illustrations or text pertaining to our national defense efforts prior to Pearl Harbor, or to our war activities since that date, have appeared within our pages which have not received the approval of the proper officials of the Army, the Navy, or the Marine Corps.—*O. D. M.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of April, 1892)

LOCOMOTIVE—"The Brooks Locomotive Works, of Dunkirk, N. Y., have recently furnished the Great Northern Railway with fifteen of the heaviest locomotives in use in this country. The general appearance of these engines may be seen by reference to the accompanying illustration. The cylinders of the first ten of these engines are 20 by 24 in., five of the ten having wagon top and five Belpaire boilers. The other five have Belpaire boilers and cylinders 20 by 26 in., which is the engine shown in our illustration. . . . This locomotive will haul, in addition to its own and the weight of the tender, the tracks being in good condition and comparatively free from curves: On a level—4,505 tons of 2,000 lbs.; on a 20 ft. grade—2,010 tons of 2,000 lbs.; on a 100 ft. grade—578 tons of 2,000 lbs."

STREETCAR—"The Woodland Avenue and West Side Street Railroad Company, of Cleveland, O., has been testing a new storage battery car, with the view of equipping its lines with the same should the test prove successful. The car measures 21 ft. inside over all and is equipped with 180 cells, which are placed under the seats, serving to operate a forty horse power Ford & Washburn motor."

INVENTORS—"The larger the number of patents granted, the greater will be the number of new industries established, and our measure of prosperity correspondingly increased As a people we have everything to gain and nothing to lose by encouraging inventors, no matter where they live or where they were born."

PECCARIES—"A recent publication of the National Museum contains a paper, by Mr. Frederic A. Lucas, on animals recently extinct or threatened with extermination He finds that in nearly every instance the cause is 'reckless slaughter by man.' As an instance of the way in which animals may be destroyed, he refers in the introduction to peccaries. In 1885 these little animals were so abundant in several counties of Texas that their well-worn trails were everywhere to be seen, while their favorite haunts could be readily picked out by the peculiar musky odor characteristic of the creatures. Shortly after that date, hogskin goods being in favor, a price of fifty cents each was offered for peccary hides, with the result that by 1890 the peccaries were practically exterminated."

OIL BURNERS—"The competition between oil fuel and coal is a most interesting one, and certainly shows an increasing use of oil where the conditions are favorable for its employment. Perhaps the most conspicuous of the advantages possessed by oil over coal as a fuel is the readiness with which the most intense heat can be employed at any special point desired, and the economy with which it can be used for just the period required. In addition, there is a great saving of labor in the use of oil, and, as there are no ashes, all the work around the boilers and furnaces can be kept in a much more cleanly condition."

CAVE DWELLERS—"The Russians have made a singular discovery in Central Asia. In Turkestan, on the right bank of the Amon Daira, in a chain of rocky hills near the Bokharan town of Karki, are a number of large caves, which, upon examination, were found to lead to an underground city, built, apparently, long before the Christian era. According to the effigies, inscriptions, and designs upon the gold and silver money unearthed from among the ruins, the existence of the town dates back to some two centuries before the birth of Christ. The edifices contain all kinds of domestic utensils, pots, urns, vases, and so forth. The high degree of civilization attained by the inhabitants of the city is shown by the fact that they built in several stories, by the symmetry of the streets and squares, and by the beauty of the baked clay and metal utensils, and of the ornaments and coins which have been found"

SPRINKLERS—"The introduction of automatic sprinklers has reduced the average loss per fire, within the experience of the Boston Manufacturers' Mutual Fire Insurance Company, where they were in service, to 8.3 per cent, and the average loss per claim to 6.9 per cent of what it is apparent that such fires and claims might have been under the previous conditions of protective apparatus"

GRIPPE—"There is much truth in the remark of one who observed: 'The worst thing about the grippe is that you are sick with it so long after you get well.'"

RAIL SPEED—"Engine No. 385 of the Central Railroad of New Jersey broke all records of high speed on February 26, by running a mile in 39¼ seconds, or at the rate of 91.7 miles per hour. The engine is a Baldwin compound. In speeding this engine the first mile was made in 76 seconds, the second in 62, the third in 53½, the fourth in 45½, and the fifth in 39¼ seconds."

PHOTO-ENGRAVING—"The first 'process' pictures, as photo-engravings were called, were very faulty, principally from the low relief obtained, which made them especially difficult to print in ordinary type forms, but by years of experiment and hard work this method of making pictures has been brought to such a degree of perfection as to practically supersede the more laborious hand engraving for quite a number of purposes."

MILITARY OBSERVATION—"The presence of balloons over the forts and encampments in Poland is becoming more frequent than ever, and this fact is causing much indignation among Russian army officers, who are helpless to prevent military secrets from becoming known to the German officers, who are known to be taking observations from a height that places them beyond the reach of any bullets aimed at them . . . Even modern cannon . . . could not be used against balloons, for the reason that gun carriages have not yet been made that allow of a perpendicular elevation."

"We're *backing them up*"

Marching right along with the armed forces of this country are thousands of telephone workers.

They work side by side with the Army and Navy. Wherever the need is communications, you are likely to find telephone men and their trucks and materials.

Day and night the order is for speed and more speed.

They wear no uniforms, these telephone workers, but men in uniform know how much they are putting into the Nation's biggest job. They see it first-hand and they know it is first-rate.

BELL TELEPHONE SYSTEM

"THE TELEPHONE HOUR" IS BROADCAST EVERY MONDAY EVENING OVER THE N.B.C. RED NETWORK

"GUNS" OF INDUSTRY POINT SKYWARD

In the manufacture of Koroseal, synthetic elastic material of many uses, made from plasticized polyvinyl chloride, a huge solvent recovery plant is needed. In relief against the sky, the towers of the Goodrich recovery unit present a striking appearance in the photograph above. The largest of the towers, at the right, is 10 feet in diameter and 78 feet high. The center one is 6½ feet by 68 feet, while the smallest is 2½ feet by 54 feet. All of the towers were received on the site completely assembled and were erected in one piece.

98TH
YEAR

SCIENTIFIC AMERICAN

APRIL
1942

GASOLINE MIRACLES

Higher Octane Aviation Fuels, But Not for Hitler

SIDNEY J. FRENCH
Professor of Chemistry, Colgate University

At this moment gasoline is the most important commodity in all the warring world It will win and lose the war. This does not mean just any gasoline; it means high-octane gasoline It means the type of gasoline that Germany, for all of her much vaunted *Luftwaffe*, would give almost anything —except Hitler—to possess. It means the type of gasoline which is peculiarly an American product, which packs the eventual knock-out wallop for Hitler and his Axis partners.

Just what is this high-octane fuel and why is it peculiarly an American product? It is American because America has produced more automobiles than all the rest of the world combined It is American because America produces 60 percent of all the petroleum used in the world. It is American because better motors kept demanding better gasoline. It is American because 25 years of intensive search and research, trial and error, comedy and tragedy, have gone into the job of producing a fuel to meet the perfectionist demands of motor makers

With what success? With such success that even the experts would not have dared predict, 25, or ten, or even five years ago. With such success that motor makers are now striving to catch up with the perfection of available fuels.

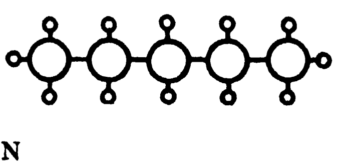
High-octane fuel is tailor-made gasoline, made to order from the crude materials provided by nature—made by cutting, patching, and sewing the very molecules of nature's product into new designs. It is one of the most remarkable stories of modern science, of sheer brilliance, in the American chemical industry.

Petroleum, source of gasoline, is nature's cocktail, a grand mixture of chemical compounds known to the chemist as hydrocarbons. In a spoonful of petroleum there are, literally, thousands of these compounds—and each one is composed of billions upon billions of tiny, identical molecules In some respects all these invisible molecules are alike—they all consist of carbon and hydrogen atoms and, furthermore, nearly all of them have their carbon atoms strung together like cranberries on a Christmas chain. Decorating each "cranberry" are "glass-headed pins" representing the hydrogen atoms. It is principally in the *number* of cranberries that make up the chain that these various hydrocarbons differ. There may be anywhere from one to 30 berries, with the number of hydrogen pins always twice the number of berries plus two.

SCIENTIFIC RESEARCH

To distinguish one of these chain compounds from another, the chemist adopts a simple expedient; he counts (in Latin) and adds the ending *-ane*. Thus, a chain of five carbon atoms is pentane; of six, hexane; of seven, heptane; of eight, octane, and so on. Unfortunately, however, the counting scheme was not started soon enough and those hydrocarbons having less than five carbon atoms still bear names unrelated to numbers: one carbon atom, methane; two, ethane; three, propane; four, butane.

Here, then, is our cranberry-pin model of pentane, with its five-carbon-atom cranberries linked together and its five-times-two-plus-two hydrogen-atom-pins stuck into the berries:



The gasoline family includes those hydrocarbons which have anywhere from five to nine cranberries in the string, plus many more deformed relatives. Starting with a petroleum cocktail, how do we get these particular strings separated from the rest?

The answer is simple: The shorter the chain, the lower the boiling point of the hydrocarbon Heat petroleum and the gasoline fraction boils off first. Next, as the boiling point of the mixture rises, comes off the kerosene fraction consisting of longer chains; followed in turn by the light lubricating oils, the heavy oils, the greases, and finally, paraffin. In this process of distillation some 20 percent of the original petroleum mixture is obtained as gasoline.

In the days when Henry Ford's Model T was beginning to make history, the small amount of gasoline obtained in this manner was sufficient. So was the quality. But the time soon arrived when neither the quantity nor the quality sufficed.

Gasoline is an explosive; that is what makes it function in an automobile cylinder. But what a difference there can be in explosives. No date-conscious person would take a swift kick at an old hat lying in his path on April the First Instead, he would shove it gingerly, and then steadily, with his toe, and thus remove the hidden brick from his path without repercussions to the toe. This is the type of gasoline we need in modern motors—the type which pushes, not kicks; the type which explodes gradually, not suddenly. As long as we stuck to the Model T car, it didn't make much difference what we used, but when motor makers began increasing the compression in their motors in order to get a more efficient engine, the fuel began to kick.

Gasoline makers were placed squarely behind the eight-ball. How could they produce a fuel that would not knock, yet at the same time how could they increase the quantity of fuel needed by a nation rapidly taking to wheels? Surprisingly enough, they did both jobs with one stroke of the knife: They cut up long molecules into shorter ones.

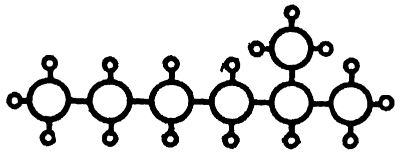
Suppose we were to cut a chain consisting, say, of 14 cranberries and the accompanying 30 pins; and suppose that we could cut it exactly in the middle. We would have two chains of heptane. Not quite, because there wouldn't be quite enough hydrogen to go around. Thus, out of one molecule of light oil we have produced two of gasoline. How was this done in practice? By heating the petroleum under pressure—in technical language, thermal cracking. This was the ingenious scheme that was developed as early as 1915 to increase the yield of gasoline. But it did far more; it greatly increased the anti-knock quality of the fuel. The very fact that there was not quite enough hydrogen to go around left these heptane molecules in what the chemist calls an unsaturated state, and these unsaturated molecules are better fuels than their saturated brethren. In one relatively simple operation both the quantity and quality of gasoline were greatly improved.

But there was one catch in the operation—the molecules did not always break in the right place; some of the molecules were too short to be useful in gasoline, others were too long.

Even this great improvement could not satisfy for long. Motor makers began stepping up the compression still more, and the gasoline makers found themselves behind the parade again. They began putting everything they could think of—except water—into the gasoline, in the hope of finding something which would silence the disturbing knock. Finally, they found the answer in that surprising substance, tetraethyl lead. Affectionately dubbed Ethyl, this compound, present in but trifling amounts, performs the miracle of retarding the explosion of gasoline—and increasing the horsepower of the motor. Just how and why it performs this miracle scientists are still trying to find out.

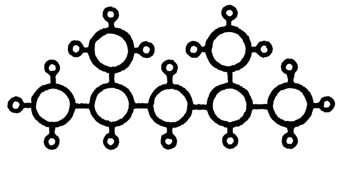
This great advance came in the 20's but it took the 30's to show the gasoline technologist just what he must do to make tailor-made gasoline. He had the goods, the raw materials, but he must cut them up, sew them, patch them, fit them to a form. It turned out to be a matter of just how the cranberries were arranged in the strings.

Given seven cranberries and 16 pins, how many different chain and cross-chain patterns can be made? The answer is, a dozen or more. We need consider only four in addition to the simple straight chain pattern. First, let us remove a cranberry from one end and place it on the side, thus:



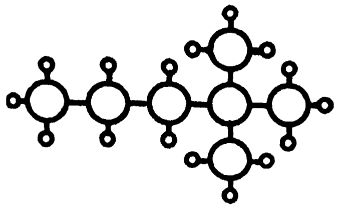
This is one of the numerous iso-heptanes. The surprising fact is, however, that this particular heptane has much better anti-knock qualities than its straight chain brother.

Now let us remove a cranberry from the other end and place it on the side; we have another iso-heptane, thus:



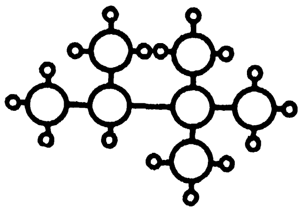
Once more the anti-knock qualities go up the scale.

Next, we arrange these side chains so that they are opposite one another, thus:



Up go the anti-knock qualities again.

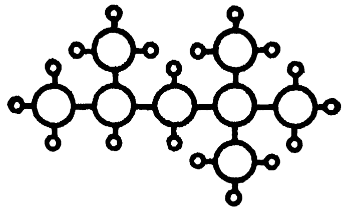
Finally, we remove another berry and place it on the side. We have the iso-heptane known as triptane:



This is the best anti-knock fuel yet discovered by man.

Here, then, is the secret of anti-knock fuel. Take a straight chain hydrocarbon of the gasoline family, pull off carbon atoms and sew them on the sides like sleeves in a coat. Tailor the goods. Much easier said than done, however.

A few years ago the fine anti-knock qualities of iso-octane were discovered. Iso-octane, like triptane, is a branched chain affair of the following pattern:



Since it was the best anti-knock gasoline then known, it was appropriately assigned an *octane number* of 100. At the other end of the octane scale was straight chain heptane, a highly audible knocker, with an octane number of zero. To determine its octane number, any given gasoline could be compared, in performance, with various mixtures of the two standards.

On this octane scale, old-fashioned gasoline used by the early Model T had an octane number of 40 to 60; thermally cracked gasoline, 70. With tetraethyl lead, the number could be boosted to about 80. Had we discovered triptane before iso-octane we would most certainly have had a scale in heptane instead of octane numbers, because this particular iso-heptane cannot even be placed on the octane scale. It is somewhere above 100. Actually it delivers about 50 percent more power than 100 octane fuel.

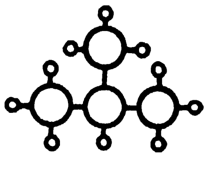
Why not use triptane for aviation fuel? Largely because aviation has been geared to 100 octane fuel and in time of emergency we dare not take the time to make the necessary change in motor design. Then, too, triptane, worth $3600 a gallon just a few years ago and still worth nearly $40 a gallon, is just a little expensive, even for war. It is safe to predict, however, that this tailor-made super-fuel will soon be available at prices low enough for use by Uncle Sam's air force—if we can find the time to make the change-over in motor design.

Yes, not too many years ago the gasoline makers were behind the eight-ball, but not today. They are ahead of the parade and calling to the motor makers to catch up. How did they do it? It is an easy matter to rearrange cranberries, but it is not so simple to rearrange atoms in invisible molecules.

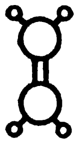
The chemists have some strange chemicals which they call catalysts. Like traffic police, these chemicals can direct chemical traffic without themselves becoming too involved in the streams. They stand apart and somehow get other molecules into the right lanes—get them united or separated as the particular case in hand demands.

It is these remarkable traffic police which have come to the aid of the gasoline technologist. First, the gasoline molecules are cracked into smaller bits by a modification of the old thermal cracking process. Then the catalysts take over and see to it that the fragments are reunited in the proper arrangement to give the branched chain hydrocarbons. True, there is always some mix-up in the traffic; some molecules never get cracked; some fragments never get united. But the vast majority go through as planned and the octane number goes up. If greater perfection is desired—if higher octane numbers are wanted—this, too, can be accomplished by the absurdly simple scheme of making the molecules go through the traffic lanes a second time. Many that were not caught on the first passage are properly apprehended and redesigned in the second attempt. To make automobile fuel, they go through once; to make aviation fuel, they go through twice. It is as simple as that!

Perhaps the most interesting of the very recent catalytic processes is that known as alkylation, coupled with another known as isomerization. Isomerization merely means the making of a branched chain molecule out of a straight chain brother of the same denomination. In the older thermal cracking process, some butane (four carbon chain) was produced and, since it was too short of chain to be useful as gasoline, it was often wasted. Now it finds a new and strategic use. It is redesigned with the aid of a catalyst into isobutane, thus:

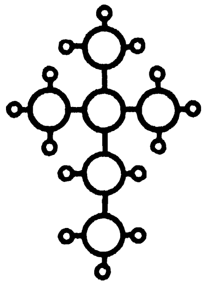


In this same cracking process the unsaturated brother of ethane (two carbon chain) was also produced, thus:



Notice that these cranberries are linked together with *two* threads.

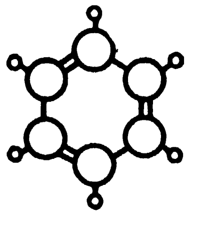
Now, presto, the traffic catalyst takes command; the iso-butane and the unsaturated brother of ethane are directed into the same channel and are ordered to unite. Out comes a molecule of iso-hexane with an octane number of 96, like this:



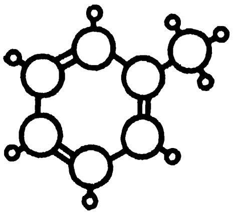
This is the type of reaction which is of great importance in the production of Uncle Sam's modern aviation fuel. Add a dash of tetraethyl lead and we get 100 octane fuel.

Octane numbers are very deceptive; they do not mean what they say because the power goes up much faster than the numbers. Triptane, with a power output of 50 percent more than 100 octane fuel, would actually have an octane number of about 110. The best that Hitler can get today is 87 octane fuel and this is 30 percent less efficient than 100 octane variety. This means that Hitler's planes must be content with less speed, lower ceilings, smaller cruising ranges, longer times for climbing to a given altitude, and more wear and tear on the motors—all to the tune of some 30 percent less in efficiency. What could we do if we could utilize our now available 110 octane fuel which should give us some 80 percent more effective power than Hitler can now get?

There is still another side to this amazing story of tailor-made products from gasoline. In World War I we heard much about Germany's stranglehold on coal-tar chemicals—dyes, drugs, and explosives—and we suffered much because we had naively depended on Germany to provide them for us. These coal-tar products are all based on hydrocarbons—but of quite a different type from those found in gasoline. Instead of being in a string, the cranberries are found in rings, six to a ring. And for each cranberry in the ring there is only one hydrogen pin, thus:



Note that the compound is unsaturated. It is our model of benzene, with its famous hexagon. To get others of these circular hydrocarbons, we may remove one or more pins and substitute decorated cranberries. Thus, we may have:

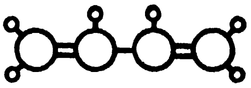


This is our model of toluene, famous as the basis of TNT, most important of modern high explosives.

A few years ago cyclic hydrocarbons of this type could be obtained only from coal tar. Now we can make them from gasoline. So desperate were we for toluene during World War I that city coal gas plants were stripped of their toluene. Today, in the brand-new hydroforming process, gasoline molecules are catalytically denuded of half of their hydrogen atoms, then are directed by the catalyst to curl up and tie their ends together. Presto! From straight chain heptane we get circular toluene.

So, today we can make our explosives—and even drugs and dyes, if necessary—directly from gasoline. We need no longer fear a shortage of toluene. Strange thing: in Hitler's country, with its paucity of petroleum, they are making gasoline from coal; in America, we reverse the process and make coal-tar products from gasoline. And incidentally, this same toluene is an excellent anti-knock fuel for motors, having an octane number above 100.

Gasoline can provide the premium fuel for our planes and the bombs to drop from them—what else can it do? It can—and probably will have to—provide the rubber for the tires. Gasoline provide rubber! Yes, strange as it may seem. The basic molecule from which rubber is formed is an unsaturated brother of butane. The chemist calls it butadiene. Here is the model:



Just as hydrogen can be stripped from heptane to make toluene, so, too, it can be stripped from butane to make butadiene. Again a catalyst is put to work directing a side chain onto this butadiene molecule. Then, much as isohexane is made, these fundamental units are tied together into long, folded strings of synthetic rubber. Given time, we can make all our rubber from gasoline and other simple substances. True, it may be a more costly process than draining a rubber tree, but the important thing is that we now know how to do it.

There are many things yet to come from nature's cocktail. What they will be is hard to imagine as yet, but we have taken the most difficult step; we have learned how to re-design the molecules. We will live to regret the years in which we have wasted precious petroleum, wasted it as a child might tear up a rare volume to get one picture. In the future we will conserve it; we will treat it as we are learning finally to treat our forests, minerals, and our other God-given wealth of natural resources. We stand today where Germany stood in 1914—master of the most important commodity of modern war. Then, it was coal tar; now, it is gasoline—tailor-made gasoline.

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PYRHELIOMETER

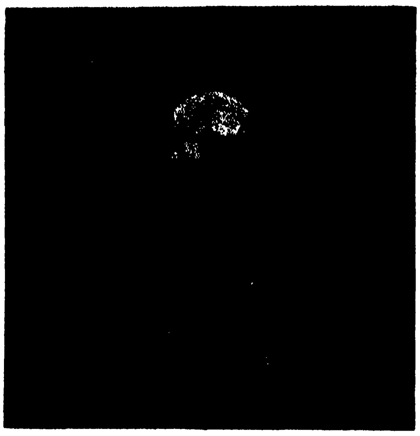
New Instrument Measures Heat of Sun's Rays

PRINCIPAL use for a new type of pyrheliometer for measuring the heat intensity of solar rays that reach the earth is for atmospheric study, yet other potential applications present themselves.

A florist might logically install a pyrheliometer in his greenhouse to determine the intensity of the sun's rays that penetrate the glass roof at various times. Agricultural experiment stations also might find a use for the device in their studies of crops and soils. The intensity of the infra-red ray used for drying paints and for similar operations also might be measured. In fact, the instrument could be applied to the intensity measurement of radiated heat of long wavelength irrespective of the visibility of that wave.

The pyrheliometer, a type of thermocouple, looks somewhat like an electric light bulb. The "filament" comprises two flat, rectangular pieces of a nickel-chromium alloy and a copper-nickel alloy, each only 50 millionths of an inch thick, $\frac{3}{16}$ of an inch long, and $\frac{3}{64}$ of an inch wide, joined end to end. This thin single piece of metal is then welded at the outer ends to vertical lead posts that lead to a stem which is wired for hook-up to a millivoltmeter. The end of the stem to which the posts are attached then is sealed into an evacuated glass bulb which is a sphere about two inches in diameter.

The pyrheliometer is mounted vertically in a fixed position with the flat edges of the "filament," or element, parallel to the earth. The heat from the solar rays striking the element produces a voltage at the junction of the welded alloys. This voltage is measured by sensitive millivoltmeters and is automatically recorded on a chart. This record then can be compared with a master chart made from known heat intensities.



Thin alloy strips in an evacuated glass bulb measure sun-ray heat

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EARTH RESISTIVITY: Recent attempts to correlate greatly differing electrical earth resistivities in different regions of the United States with the geological structure of the earth in the same region shows that the resistivity is usually lower in regions of recent geological origin. The resistivities vary from six ohms between the opposite faces of a cube one meter on a side in Oklahoma to 7000 similar "ohm-meters" in Maine and 10,000 in northern Georgia.—Bell Laboratories Record.

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ELEMENT 61

Appears Briefly Then Disintegrates

A FORM of element 61, believed to be the only element of the 92 in the chemist's periodic table not found in nature and never before produced artificially, made a brief appearance recently as a result of bombardment of other elements with atomic fragments whirled at them by the University of California's cyclotron.

The new substance stayed just long enough to show by its radioactivity that it was present and then disappeared completely by disintegration, according to *Science Service*.

The experiments were made by Dr. Emilio Segre, research associate in the Radiation Laboratory, and Dr. Chien Shiung-Wu, research fellow. The rare earths bombarded were sent to Dr. Segre a year ago by an Italian chemist, Dr. Luigi Rolla.

Element 61 belongs to the group of rare earths, of which there are 15. The atomic number 61 means that the nucleus or central core of its atom has a positive charge 61 times that on the nucleus of a hydrogen atom, and this is neutralized by 61 negative electrons revolving about it like planets around a central sun. Each chemical element has various forms, known as isotopes, and one of these of element 61 is believed to have been discovered.

From its position in the periodic table, scientists know that the atomic weight of element 61 should be about 148, and can predict fairly accurately its principal chemical and physical properties. But unless and until a fairly stable form is found, one that will at least stick around long enough to be measured, these predictions cannot be verified.

STEREOSCOPIC

Views Now Possible With Electron Microscope

THREE-DIMENSIONAL, or stereoscopic, pictures of infinitesimal bits from the submicroscopic world, are now possible by means of the electron microscope, it was announced recently by Dr. V. K. Zworykin and James Hillier, of RCA Laboratories, in presenting a joint paper at the annual meeting of the American Association for the Advancement of Science

They revealed a new photographic technique, which adds depth to the length and breadth of images as they appear in the micrographs, as the photographs taken directly from the electron miscroscope, which recently made it possible to photograph the influenza virus for the first time, becomes an even more powerful tool for use in pure science as well as industrial research.

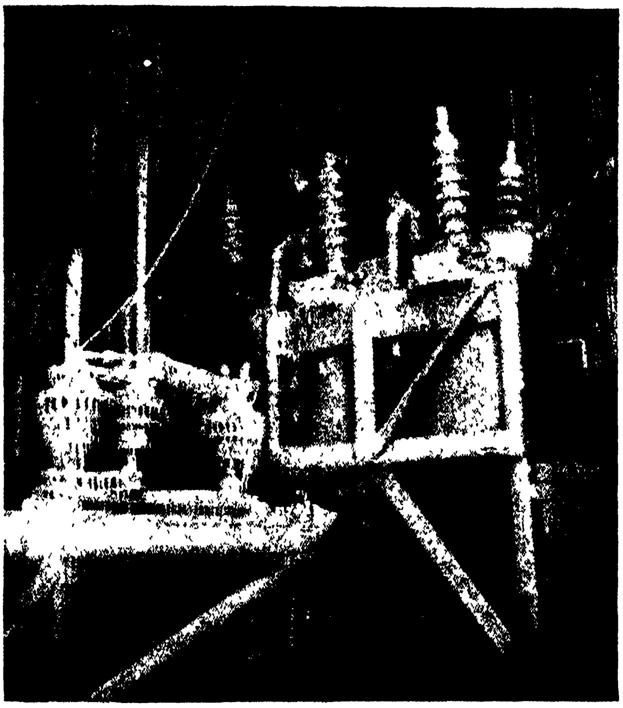
The electron microscope is especially well suited to the preparation of three-dimensional pictures, Zworykin and Hillier said, because of its remarkable depth of focus. Two pictures of the object are taken in succession, the object in a special holder being tilted through a fixed small angle with respect to the instrument's axis, first in one direction and then in the opposite. When the two pictures so obtained are placed in an ordinary stereoscope, the object, greatly magnified, appears in its proper space relationship.

Testing with 'Lightning Bolts'

Mighty Generators Provide Two Million Kilowatts To Prove Efficiency of Power-Line Guardians

A. P. PECK

A SABOTEUR has gained entrance, by devious means, to a power station. Watching his chance, he slyly throws a metal bar across one of the main circuits. A blinding flash, as the power is short-circuited, and his work is done—if a circuit breaker fails to accomplish its designed purpose of standing constant guard over the line. Or a large bird, touching two wires of a power line, may accomplish the same end Sleet and snow storms may break and ground line wires, and even rats crawling between conductors in a power house may cause short circuits. In all cases, however, circuit breakers of one sort or another are on the job to prevent the sudden surge of current, caused by the short circuits, from doing extensive damage



Man-made sleet storms test an oil circuit breaker

But, in these days of increased power loads everywhere, brought about by the demands of defense industries, how can it be determined in advance that the circuit breakers will take the load, will cut off the power in the few seconds that spell the difference between protection and disaster? Since it is not practical to wait for such proof under operating conditions, or purposely to create short circuits in power lines in use, Westinghouse engineers have recently put into regular service a high-power testing laboratory where protective devices can be proved at powers in excess of those to which they might be subjected under the most severe field conditions.

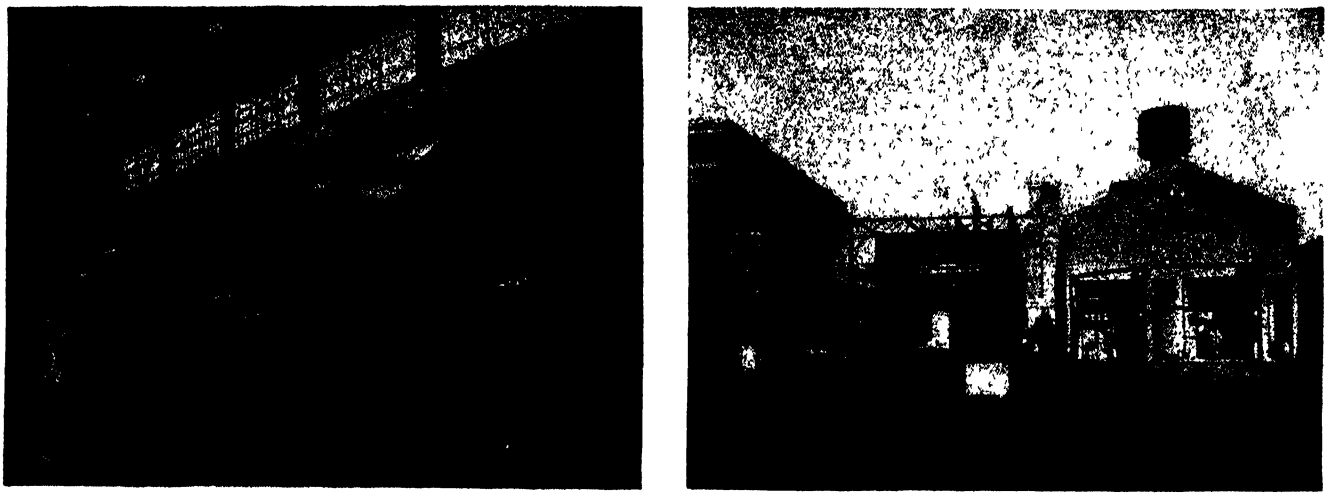
The power source for the new testing laboratory is a twin 500-ton generator set capable of delivering test charges carrying twice as much power as is produced at any instant at Niagara Falls. Each of these two generators, the second of which was recently completed to make possible testing of the largest types of protective devices before they are put into service, is driven by a 6000-horsepower motor. They are designed to produce electric "knock-out punches" in excess of 2,000,000 kilowatts, the mechanical equivalent of which is over 2,680,000 horsepower. It has been estimated that if the generators could continuously deliver their combined output, they would supply sufficient energy to light enough tube-shaped fluorescent lamps to encircle the earth twice at the equator The generators were designed, however, not for continuous service but for tests in which they deliver their energy over a time period of five seconds maximum. Thus they might be compared to a prize fighter who can pack terrific power into a knock-out punch but cannot deliver many such powerful blows in succession without resting. In the case of generators, the punch is produced electrically by short circuiting the output of the machines

Spinning at their top speed of 514 revolutions a minute, the generators' two 300-ton rotors set up vibrations, when short circuited, that shake the very foundations of the laboratory building in which they are housed. When the energy is suddenly drained from the machines, the entire 1000-ton mass of the two units recoils like a gun. Special spring-steel mountings take up the shock to protect the reinforced concrete foundations.

The electric power output from the generators can be fed through a bank of transformers in an outdoor yard where the voltage can be raised to 396,000 volts for special tests on insulation. Other transformers can be cut into the circuit to increase the current to 345,000 amperes. Distribution of power from the generators is controlled from two switchboards in the power laboratory, each 20 feet tall and studded with knife-type switches made of copper bars about two inches wide and a quarter inch thick. Here, too, are switches which, a twentieth of a second after a signal from the control room, automatically snap shut under a pressure of 6000 pounds to release the power of the generators to the equipment to be tested.

For the protection of the high-power laboratory machinery, ten photo-electric cells are located at strategic points in the power house. If an arc should flash across the terminals of one of the switches or across the windings of one of the generators, the photo-cells would "see" the arc and set in motion the necessary mechanism to actuate switches that would disconnect the power before damage is done.

For use in connection with the test generators there has been set up a series of cells where equipment to be proved can be installed and tested. These cells, with one side open, are all visible from a control room where engineers supervise the testing activities through a system of loud speaking telephones. In this control room, also, is located an oscillograph which records the results of tests on photographic film. When a switch in the control room is closed, a row of notched rotating steel disks goes into action, synchronizing the release of power from the generators with the motion inside a circuit breaker being tested and with the recording instruments. A twentieth of a second after the notch of the first disk makes contact, the master switch in the power house closes automatically, releasing a "lightning bolt" into a circuit breaker, fuse, or other device under test. At



Left: **Power twins that produce momentary torrents of 2,000,000 kilowatts.** *Right:* **Power house, other testing facilities**

the same time the oscillograph goes into action, recording by wavy gray lines the voltage and amperage of the electricity shot through the unit being tested, how quickly the device cut off the electricity, and, in a circuit breaker test, the pressure of oil or air which quenched the electric arc.

As noted earlier in this article, there are many ways in which a short circuit can occur on a high-power transmission line. If no protective devices were employed, such a short circuit would start a flood of power through the electrical system 20 to 30 times as great as the system was designed to carry. If not checked, this abnormal power would heat up wires, generators, and motors, burning off insulation in less than a minute and creating damage that it might take years to repair.

Such disasters are normally prevented by the use of circuit breakers of various types which stand guard on every power line and every branch of every line. Simplest of circuit breakers are fuses such as used in the home. When a short circuit occurs in a fuse-protected line, the fuse link burns out, disconnecting the defective part of the system until the short circuit is removed, yet allowing the remainder of the system to continue in operation without danger. Such fuses, although used on occasion even in high-power lines, require manual replacement before the defective circuit can be put back into service. Thus it is that circuit breakers are frequently employed to halt the flow of electricity into a short-circuited section of a power system until the damage can be repaired. According to engineers familiar with high-power circuit operation, a majority of short circuits—such as those caused by lightning, animals, and wind—last only for a fraction of a second. In such a case the circuit breaker opens for a short space of time and then automatically reconnects the line so quickly that the power interruption is scarcely noticed. Some circuit breakers are designed to re-establish the connection once and then, if the trouble has not disappeared, to open and remain open until manually closed; others will reconnect two or even three times before remaining open.

But the job of a circuit breaker is not finished when its contacts open In high-power operation, an electric arc is formed in the gap between the device's opened contacts. As long as this arc continues, the power line is not completely disconnected and the destructive high power of the short circuit can continue to spread to all parts of the system. To accomplish the feat of extinguishing this arc, two general systems are employed. In one of them, the mechanism of the breaker is immersed in oil contained in a steel tank. As the contact breaker opens, under the influence of a short circuit, the arc is drawn into a chamber containing metal plates. Magnetic action set up by these plates forces the arc into constricted sections where it is smothered by the oil. In the most modern of the protective devices, compressed air is used to blow out short-circuit arcs. In less than a hundredth of a second a compressed-air circuit breaker can cool an arc from a temperature of 9000 degrees to 200 degrees, snuffing it much as a puff of breath blows out a candle.

In these compressed-air circuit breakers, a small relay is provided which instantly detects a short circuit and sets in motion the mechanism of the breaker. The relay opens a valve and releases compressed air against the top of a piston which spreads the breaker's contacts apart. This action also operates another valve, releasing a 150-pound blast of air which forces the arc into a fan-shaped chamber where the air pressure breaks the arc into short sections and annihilates it.

In a recent demonstration of the Westinghouse high-power testing laboratory it was shown how the output of the 2,000,000-kilowatt generators is used to test these line protective devices. To indicate vividly the amount of power employed in these tests, the laboratory generators were connected to two curved pieces of heavy wire extending upward from a fuse link. When the power was shot into the link, the fuse instantly let go, starting an arc which traveled upward between the two wires of the gap, eventually leaping the upper end of the gap in a 20-foot waving, flaming, thundering arc as bright as the mid-day sun and hot enough instantly to melt the hardest steel.

Continuing the demonstration, the same amount of power was then fed into an oil circuit breaker located in one of the test cells. Within a twentieth of a second after the release of the 2,000,000-kilowatt surge of electricity—simulating conditions more conducive to disaster than would prevail during the short circuiting of the highest power transmission line in existence—the circuit breaker emitted a mechanical grunt, blotting out the flood of power quicker than the blink of an eye.

In another test it was shown how a compressed-air circuit breaker blew out the high-power arc. To illustrate the magnetic forces in the cables carrying the charge in different tests, the inch-thick copper cables were sandwiched between six-inch timbers, which were bound with half-inch rope. The surge of power set up magnetic forces which thrust the cable apart with such violence that the rope was snapped like twine and the timbers split into kindling.

Another phase of power line protecting test work which is being accomplished at this new laboratory is the checking of equipment operation at low temperatures. A room-sized refrigerator has been installed as a part of the laboratory, where temperatures of 20 degrees below zero can be produced. In this refrigerator can be set up various types of switches, insulators, and so on, to be tested with the high power under varying conditions of cold. During the recent demonstration, the temperature of the room had been reduced to a point where a power switch, mounted on porcelain insulators, was covered with a thick coating of ice. When current, at a pressure of 60,000 volts, was fed through the switch, a corona discharge formed around the porcelain insulator separating the switch contacts from the steel base. As the voltage was raised gradually, the corona increased in brightness until, at 120,000 volts, a crack of thunder filled the room and a brilliant arc jumped from the switch contacts to the steel base.

"Such tests as this tell how well insulated these switches must be when encrusted with ice," explained one of the engineers in charge of the work. "Since ice reduces the insulating quality of porcelain, the insulators on these winter-proof switches must be made tall enough so that electricity will not arc, or jump, from contacts to base when the line carries its normal voltage."

Thus, test torrents of electricity, created in the mightiest laboratory of its kind, make it possible to avoid interruption of the flow of vital power in the transmission lines of the nation, by making doubly sure that protective devices can cope with even the worst troubles that might arise.

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Recap to Keep 'em Rolling

Old Tires and Retreading Play Important Roles in America's Wartime Transportation Picture

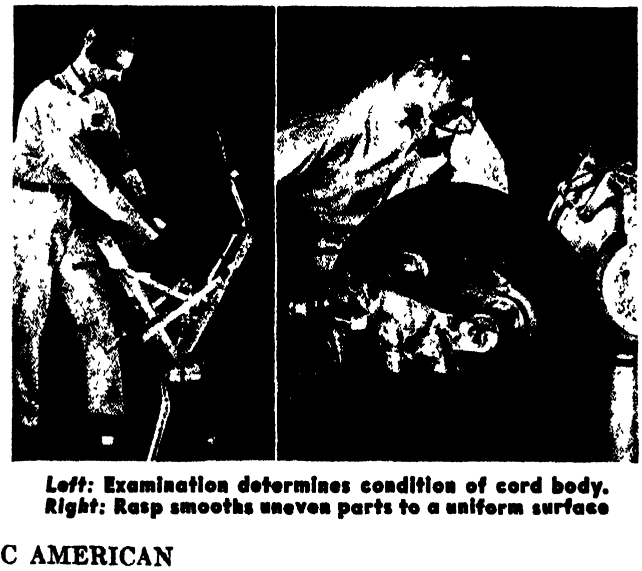
JULIAN J. WILSON

UNLESS his automobile, truck or motorcycle is used directly in war production, or in activities deemed essential to the national welfare, the American car owner cannot buy a new tire for some time to come. Conceivably, this might not be possible until complete victory is achieved over Japan and her Axis partners. And, so far, no responsible official has stepped forward to predict that this is going to be a short war.

Just how much tire rationing may disrupt our national life is hard to say. For a people who have centered so much of their industrial and recreational habits around the easy transportation facilities of the automobile, the rubber shortage will not be painless. Realizing this fact, the motorist has been asking the gasoline station attendant and the garage mechanic one question:

"How can I get more miles out of my present tires?"

The answers to this question are brief and simple, according to development engineers of the rubber companies. They say emphatically that there are two things the motorist can and must do to get the maximum mileage life from his tires First, he will have to eliminate those practices which *waste* the miles of service that are now available in his tires. Secondly, when present tires have delivered all of the safe mileage of which they are potentially capable, the car owner should have these tires retreaded, if possible, thereby insuring many additional thousands of miles of safe dependable service.



Left: Examination determines condition of cord body. Right: Rasp smooths uneven parts to a uniform surface

Taxicab owners, trucking fleet operators, and others have long recognized the economy of the extra tire mileage made possible by retreading. Instead of discarding a tire when tread wear has approached the danger point, these operators have had it retreaded for less than the cost of a new tire. Records show that one taxicab operator has had sets of tires retreaded as many as five times, and these tires are still in use after delivering over 100,000 miles.

It must be pointed out, however, that no tire can be retreaded indefinitely. Regardless of tread condition, a tire is only as good as its cord body. It is considered practical to retread a tire a second or third time, if the cord body and sidewalls of the tire remain in good condition. But if the cord body has been damaged or weakened to the point where it will not stand up for the additional miles which a retread is capable of giving, it is a waste of rubber to retread it the first time.

IN a bulletin to the rubber industry establishing maximum prices for retreading, put into effect January 19th, the Office of Price Administration has given technical definitions of the terms used throughout the retreading industry, to clarify the rulings of that department. These definitions are as follows:

"Retreading means the process of reconditioning a tire by removing all the original tread rubber from the worn tire down to the fabric and applying new rubber to the tread surface and sidewalls;

"Recapping means the process of applying a top cap or full cap to a used rubber tire;

"Top cap means a tread renewal where the worn tread of the tire is buffed off the top surface of the tire and new rubber is applied to the tread surface only;

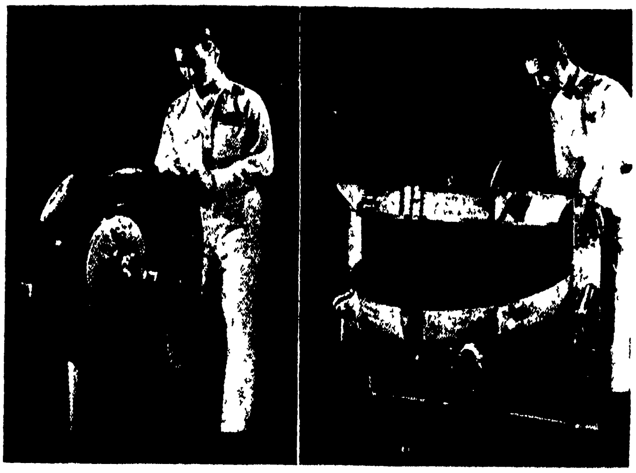
"Full cap means a tread renewal where, in addition to buffing off the worn tread, the shoulders of the tire also are buffed below the shoulder design and new rubber is applied to both the tread surface and tire shoulders;

"Camelback means the uncured rubber compound applied to the worn tire to make the new tread in the process of retreading."

The retreading or full capping of passenger car tires, as defined above, however, was made impossible by an OPM order effective January 12, which stopped all production of camelback of the sizes used for "retreading" or "full capping" of passenger car tires. On

February 19 an order went into effect rationing the camelback material for all purposes.

These rulings, made because of the necessity of conserving every possible ounce of rubber for wartime purposes, may, in reality, help the motorist to get more mileage from his tires. Before the rubber shortage it was the practice of many drivers to overwork their tires and to disregard simple rules for getting the greatest possible mileage from the original rubber. Too frequently, tires were run past the danger point, where the tread rubber was almost completely worn off, leaving parts of the cord fabric exposed to wear. As a result, many tires which could have been top capped a relatively few miles earlier, have had to be discarded. Longest mileage at lowest cost per mile can be obtained if the tire is top treaded when 20 percent to 25 percent of the normal tread life of the tire remains. This means a covering of 1/16 inch to 1/8 inch of tread rubber, which is sufficient to provide a solid foundation for the new tread rubber and, at the same time, protect the cord body.



Left: **Tread stock, or camelback, is applied and, (right) vulcanized to bond to tire body and to form new tread**

Before a tire is accepted for top capping at a well operated retreading plant, it is first given a thorough examination by an experienced tire repairman. If the cord body shows cuts, breaks, or any other weakness which would tend to shorten the life of the tire after top capping, it is rejected. Rubber is too valuable to waste on weak tires. Only if the cord body is in condition to stand sufficient additional mileage will the tire be accepted.

The accepted tire is placed on a buffing machine which brings it into contact with a whirling rasp to buff the worn tread. This provides an even surface to which the camelback is applied. The camelback is then bonded to the surface with a special tire cement which holds it in place for further processing. Next, the tire is placed in the curing mold where the action of heat upon the camelback vulcanizes the tread and makes it an integral part of the original tire.

Those tires which are not accepted for retreading or recapping because of the weakened condition of the cord body, while useless in themselves, still are not a total waste. Through chemical processes, the rubber in these tires is separated from the cord body and the other materials that were used originally in making the tire. This reclaimed rubber can be mixed with new rubber in definite proportions and be used again for retreading.

The question most frequently asked is: "How will the mileage of a retreaded or recapped tire compare with that of a new tire?" No truly accurate answer can be given. That depends on the condition of the cord body of the tire, the methods under which it is retreaded, the quality of the camelback used, and the care it is given after it is returned to service.

If only three or four of the most simple rules of tire maintenance and driving care are followed, American motorists can extend tire life by untold millions of miles.

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YOUR TIRES WILL LAST LONGER IF YOU:

1. **Keep them properly inflated**
2. **Have a regular day for inflation**
3. **Drive at moderate speeds**
4. **Keep the wheels aligned**
5. **Start and stop gradually**
6. **Have cuts repaired immediately**
7. **Have experienced tiremen check them every month.**

Regardless of the effect of the War Production Board's order of February 19th on rationing of retreaded and recapped tires, this informative article will help all motorists

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The two most prevalent causes of mileage waste are high speeds and incorrect inflation. A tire driven at an average speed of 50 miles an hour will deliver only 60 percent of the mileage it will return at 30 miles an hour. If the speed is stepped up to 60 miles an hour, only 45 percent of the potential mileage will be returned—55 percent wasted.

Incorrect inflation is just as wasteful as speed. Thirty pounds of air is the recommended air pressure for tires on many cars. If such a tire is operated at 27 pounds pressure, 21 percent of its potential mileage is wasted. A drop to 21 pounds pressure will result in a waste of 52 percent of its normal mileage life. The average tire loses three pounds of air a week, and should be inflated regularly to keep it to the recommended level.

Nor should over-inflation be practiced if the operator expects to get full mileage from his tires. Over-inflation reduces the amount of tread in contact with the road, induces slipping or spinning of the tire in stopping and starting. An over-inflated tire is also more susceptible to cuts and rim bruises

Another thief of tire mileage is a wheel which is not in proper alignment. This shows up vividly in field tests. When two opposite wheels on an automobile do not run parallel to each other, one grips the road and runs in a straight line. The other is dragged sideways at an angle. A tire on a wheel which is only one-half inch out of alignment is dragged sideways 87 feet in every mile, causing excessive wear on one shoulder of the tire Other mechanical faults, such as loose wheel bearings, worn bushings, loose steering connections, uneven brake action, bent axles, or any mechanical condition that impairs the straight, true running of the wheels will cost miles in terms of tire life.

There is a definite schedule of rotation of tires which, if followed every 5000 miles, will add extra miles. It is not necessary to remove the tires from the wheels in making this rotation. The procedure is first to move the front wheels to the rear positions on the same side. On the second move, shift the rear wheels diagonally to the front position It is good policy to put the spare tire into use every alternate 5000 miles, as it is subject to deterioration if left unused for too long a time.

National surveys, made by The Firestone Tire & Rubber Company, show that the average motorist normally operates his car 20,000 miles on one set of new tires before replacing or retreading them. From records of field tests, where cars are operated under normal driving conditions, it has been definitely established that this figure can be raised safely to 30,000 miles, or even doubled, when proper precaution is taken in the care of the tires.

As a result of these extensive surveys there has been prepared a table of recommendations for the care of motor-car tires. If these recommendations, set forth on the preceding page of this article, are followed by American motor-car drivers, the result will be an enormous over-all increase in tire life.

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RECLAIMED

Metals From Mill Chips and Scale

Every pound of mill scale, chips, and grinding dust accumulated in the past year in the plant of a tool-steel producer has been carefully saved. Periodically, they are gathered and shipped to a refining plant 550 miles away. There thousands of dollars' worth of vital raw materials like tungsten, chromium, and vanadium have been salvaged and shipped back to the tool-steel maker to help conserve the nation's reserves of those strategic metals.

WIRE SALVAGE

Made Economical by New Winch

Wire reclaiming winches and reels, produced by Gar Wood Industries, Inc., are now being used for fast and economical reclamation of telephone line wire. The winch saves in the cost of removal and also in the cost of maintenance since the wire removed is ready either for immediate re-use or to be sold to smaller companies for their requirements.

Ten miles of wire an hour

The wire reclaiming winch will reclaim all sizes of copper and iron telephone wire from poles. The winch will coil ten miles of wire in one hour and coil this wire in a form suitable for immediate use. When necessary to remove wire to put up new lines, it has heretofore been the custom to pull one short wire at a time on a collapsible reel. This was not only a slow process but also the wire was bent around the arms of the reel, making the wire useless except to sell as junk material. With the new winch, ten wires (each a mile long) can be coiled at the same time at a speed of 150 feet per minute; the reclaimed coils of wire are nearly as perfect as original factory coils of new wire.

IRON RESEARCH

Yields Method of Using Low-Grade Ore

A research project on iron ore, which Henry Ford pushed steadily along for a dozen years despite meager results, now has opened additional possibilities in metallurgy and for automotive and defense manufacture. Experiments have produced a way to recover iron from vast deposits of unwanted, low-grade ore. But, even more significant, the iron obtained by the new method has some unusual characteristics that make it particularly useful in the new field of powder metallurgy.

Unlike ordinary iron recovered by smelting, the iron Ford has obtained is more ductile, it resists corrosion, and it has magnetic properties that improve motor-car performance.

Huge deposits of poor ore, much of it in Michigan's upper peninsula, were the original object of the Ford experiments. Smelting was ruled out as a method of iron recovery because of excessive cost Research men tried a number of recovery methods and finally settled on electrolysis. The theory is not new, but Mr. Ford believes that an electrolytic method which would be feasible commercially has been perfected for special purposes

The method of recovering iron from low-grade ore is really a system of electro-plating, and for work on an industrial basis, cheap electric power is essential. The system works this way· Iron is dissolved out of the ore in chemical solution, then is plated out of the solution by electrolysis. One electrode is coated with iron 99 percent or more pure, which can be removed in sheet form. Since the sheet contains a slight amount of hydrogen, it is easily pulverized for use in powder metallurgy. On the other hand, if the sheet is heated slightly, the hydrogen is driven off and the iron becomes ductile.

New avenues in industry seem certain to be opened by this method. The iron powder can be molded into high-precision gears in a single press operation, producing a gear that needs no machining. The advantages of electrolytic iron are not limited to manufacturing, according to Mr. Ford. Motor-car performance may also be improved by using it. For example, cores of distributor coils now in general use sometimes tend to lose their high spark efficiency at high speeds because the core remains partly magnetized between spark impulses. The electrolytic iron cores produced in the laboratory have shown high spark output at all speeds because this type of iron does not retain magnetism between electric impulses.

Of first importance in the decision to push the research program through to success was Mr. Ford's concern for communities near iron mines which had been abandoned because of the low quality of the ore. This has happened in several places in Upper Michigan. "Nobody wants that impure ore now because it costs too much to handle," says Mr. Ford. "If ore doesn't contain at least 40 percent iron, it isn't considered worthwhile to ship it to the furnaces. A lot of the ore in Upper Michigan is 20 and 30 percent stuff—it's full of dirt and other impurities. And that's just the kind of ore we have experimented with in working out our method of iron recovery."

CONDUCTIVITY CHECKS

Prove Their Value in Many Processes

Because of simplicity, accuracy, speed, and moderate cost, the electrolytic conductivity method of measuring and checking many materials is coming into extensive use in laboratories, industrial plants, and in the field. This technique can be applied to a wide range of chemical values, solution concentrations, water purity, the degree of rinse, and other matters. Indeed, whenever the electrolytic conductivity of a given item can be correlated with the desired factor such as concentration or moisture content, the conductivity bridge serves as the logical measuring and checking means in providing precise readings at the mere twist of a knob, thereby eliminating troublesome, time-consuming procedures, often requiring chemical analysis.

The conductivity bridge, of the type built by Industrial Instruments, Inc., for example, measures specific resistance of electrolytes from .2 to 2,000,000 ohms. Accuracy of measurements comes within 1 percent except for extreme ends of calibration, and is entirely independent of line voltage variations.

The conductivity bridge plays an important role in checking distilled water for purity, dissolved solids concentration of tap water, boiler feed water and condensates, acidity or alkalinity by conductometric titration, and water used in various processes where special characteristics are desired.

Many organic compounds in the pure state have exceptionally high specific resistance. Slight traces of impurities in these compounds, including traces of water, decrease the specific resistance to a marked degree. Conductivity measurements have therefore been found to be extremely valuable in detecting traces of moisture or impurities in organic compounds, and in some cases have been made part of the specifications since conductivity will reveal the presence of infinitestimal amounts of contaminant, or moisture, which defy other methods of analysis.

And of course the conductivity bridge can be used as a standard Wheatstone Bridge for conventional electrical work such as checking carbon and wire-wound resistors, calibrating rheostats and potentiometers, checking leakage, and so on.

COFFEE SEARCH

Fails, but Points to Better Diesel Filter

How one man's passion for good coffee resulted in a unique industrial contribution to the war effort was disclosed recently by the Moraine Products Division of General Motors. Better Diesel engines for submarines, tanks, trucks, and other vital power applications are being produced because Earl Patch, Moraine Products sales manager, wanted a better cup of coffee and didn't know how to make it.

Here is how the story is told:

Item 1. Moraine Products, a pioneer in the field of powder metallurgy, makes bearings that soak up oil the way a sponge absorbs water.

Item 2. One day Earl Patch brought a percolator to the office and said: "If we can make a piece of metal that will soak up oil, why can't we make a piece of metal that will drip coffee?" "Why not?" answered Roland Koehring, research engineer.

Item 3. Fortunately, neither Patch nor Koehring knew a thing about scientific coffee making. If they had, they never would have tackled the job. They experimented and experimented but without success.

Item 4. Then J. H. Davis, general manager, got interested. He suggested another approach, an approach so simple it had never occurred to the others.

Item 5. The new method works. Out of the sintering furnace comes what looks like a cake of coarse, bright-colored sand similar to those made by children. But, unlike a sand cake, it doesn't crumble.

Item 6. The first batch of coffee is perfect.

Item 7. The second is fair.

Item 8. The third is terrible.

Item 9. From a book on coffee Patch and Koehring learn why. They learn that the grounds lodged in the pores of the filter and turned rancid. They learn that a coffee expert can even spot a cracked cup by the taste of the beverage.

Item 10. But the story has a happy ending. The filter was found to be just the thing engineers of the Detroit Diesel Engine Division of General Motors were looking for to prevent the tiny holes in Diesel fuel injectors from clogging.

• • •

BUSINESS BUILDER: As a result of industrial research, every fourth worker is working today in an industry which did not exist 40 years ago.

• • •

SOYBEAN FIBER

Now Being Produced on Limited Scale

Limited production of a synthetic fiber developed from soybeans—a fiber similar to sheep's wool—has been announced by the Ford Motor Company. Spun from a molasses-like substance that contains soybean protein as its principal ingredient, the fiber is derived from the lowly farm crop that has come into industrial prominence.

The company has been operating a "pilot" mill at its Highland Park plant for several months which is capable of spinning upwards of 1000 pounds of the fiber a day. For the present, the fiber production rate will be maintained at approximately this figure in a new plant in Dearborn.

The synthetic product is said to be best used when blended with sheep's wool. Research chemists who developed the material estimate that eventually the thousands of pounds of wool now used annually in upholstery can be supplemented by at least 25 percent of this new fiber. Early production will be put to this use, for which the new product is ideally suited because of natural crimp and a high degree of resiliency.

The complicated processing of the soybean begins with the extraction of the oil. Protein from which the fiber is made, after being removed from the oil-free meal, is dissolved to produce a viscous substance that emerges from a 500-hole spinneret looking not unlike fine noodles. The extruded filaments are run through an acid bath and later, after immersion in formaldehyde to completely set the fiber, they are cut to desired staple length and dried under controlled temperature and humidity conditions. The fiber is then submitted to a half dozen other operations, all of which prepare it for spinning. After being spun, it is shipped to the upholstery mills. Wool and other fibers are added there.

PIPE LINES

Many Miles Built During 1941

America's "underground railway," its network of petroleum pipe lines, gets longer every year. In 1941 the petroleum industry added more than 4500 miles of this unsinkable transportation to its systems, about half of it in strategic locations directly concerned with national defense. The remainder was built in the normal, continuing expansion of an industry which finds new oil fields every year and must connect them with its refineries; refined products are also carried from the refinery to the market by pipe lines.

MANGANESE

From Low-Grade Ores In the United States

Manganese sufficient for all our national needs can be produced right here in the United States as the result of a new process for the treatment of low grade ores developed by the Bureau of Mines. Success of the process depends on the use of a new reagent developed as a result of researches in the laboratories of the Bureau of Mines, and known as DLT-958. This reagent floats a good part of the worthless materials away from the ore, leaving a concentrate from which the metal can be extracted by the usual process. The Bureau has also developed other reagents of a similar character.

The Bureau has built, under a defense appropriation, a group of pilot plants at Boulder City, Nevada, of which the first unit has begun operations. The first test of the new reagent was made in this mill on ore containing 18 percent of manganese. It left a concentrate containing 53 percent of manganese.

INDUSTRIAL TRENDS

THIS RUBBER SITUATION

Up to the tragic date of December 7, 1941, the chemical industry of the United States was planning, in the orderly manner typical of past performances, for production of various materials for national defense. But the bombs at Pearl Harbor changed all this. Where minor shortages of materials existed before, there were found drastic scarcities; where experimental planning for future possible production had been underway, there suddenly loomed the necessity for full-scale operation of plants still on the drawing boards.

Synthetic rubber was the one product of the chemical laboratory that received the greatest publicity after the declaration of war bit even deeper into the already critical situation in natural rubber. But even today, months after Pearl Harbor, there is still some misunderstanding about synthetic rubber and its production possibilities

First, it must be understood that the term "synthetic rubber" applies not to one product alone, but to a number of synthetics produced from a variety of raw materials. Secondly, it is not the scarcity of these materials that is the choke point in synthetic rubber production; plants must be built, and electric power must be provided for operation.

The chemists are ready with a variety of formulas for compounding synthetic rubbers For some time past Du Pont has been making neoprene from an acetylene base, the resulting product having been proved by practice in a number of industrial applications Vinyl plastics, by Union Carbide and Carbon, have been substituting for rubber in many fields Koroseal, a synthetic produced by Goodrich, is being pushed to greater production figures than ever before, and a vehicle tire of synthetic rubber is being made by the same company Standard Oil of New Jersey will soon be heard from in a big way with another synthetic for tires Into the same picture come Dow Chemical and American Cyanamid as suppliers of raw materials and Monsanto as a source of processing chemicals

In the meantime, research laboratories are working overtime on new formulas for producing the synthetic rubbers The possibilities are almost unlimited, there being literally hundreds of basic chemical forms, obtainable from coal, or oil, or both, that can be combined with other materials to produce innumerable types of synthetic rubbers with varying characteristics to suit almost any designed purpose.

It appears now that, subject to change without notice, the aim of the whole synthetic rubber industry will be toward capacity for producing some 150,000 tons annually, this is about half of the probable ultimate production that will be necessary, it being estimated now that the goal of this industry must be placed at producing about half of our 600,000 tons of rubber consumed annually. By the time the 150,000-ton point has been reached, it is probable that research will have developed newer and better synthetics that can be produced at lower cost

In any consideration of this important phase of our all-out war effort, it must be remembered that chemists in the synthetic rubber field are working under a suddenly imposed handicap. For years they were experimenting in this field without any immediate pressure other than that of producing a material with industrial possibilities. Then came the natural rubber shortage—and insistent demands for synthetics in large-scale production. There are, thus, many phases yet to be fully explored, phases that will undoubtedly change the synthetic-rubber picture when they have been opened up by the ingenuity of American chemists.

50 PERCENT PRODUCTION

An industrial production figure that has been widely quoted, but without sufficient explanation, has led to some misunderstanding regarding the total war effort of American industry. This figure places war-production requirements of all sorts at only 50 percent of the total productive capacity of the nation. This would seem, on the surface, to indicate a possibility of business as usual for many companies engaged in businesses outside the war effort. But the figure is one of those misleading overall estimates; there are thousands of firms engaged in luxury-item and other non-essential production that are finding raw materials more and more difficult to obtain Many of these will be forced out of business, some will obtain only a bare minimum of supplies, while a few will be affected only slightly.

Unfortunately, that 50-percent figure can be spread only just so thin; then it tapers off to nothing

PUTTING WORDS ON PAPER

Typewriter manufacturers are feeling the demands of war production in two ways. The typewriter itself has become an implement of war, lubricating the wheels that produce the enormously increased amount of paper-work in defense industries and in government departments At the same time, materials shortages have struck at typewriter production a bit harder, if anything, than at many other industries.

It is encouraging, therefore, to note, in a recent report from the Royal Typewriter Company, that these shortages have had, in certain aspects, a beneficial effect on the industry as a whole Substitutes for critical metals have been developed and design improvements, incorporating these alternate materials, have been made Net result is being shown in better machines for putting words on paper, and the foreshadowing of even more efficient machines for lubricating the wheels of peace in days to come.

IN NEW DRESS

The packaging industry in general is hard at work following the general trend of re-design made necessary by the withdrawal from civilian use of many materials heretofore considered essential Thus research is being directed toward plastic and paper tubes to replace the collapsible metal tubes used for toothpaste, shaving creams, and so on; the tin, lead, and aluminum formerly used will soon be out of this particular picture. Glass and wood are other possible alternates for use where the material to be packaged can be adapted to such containers.

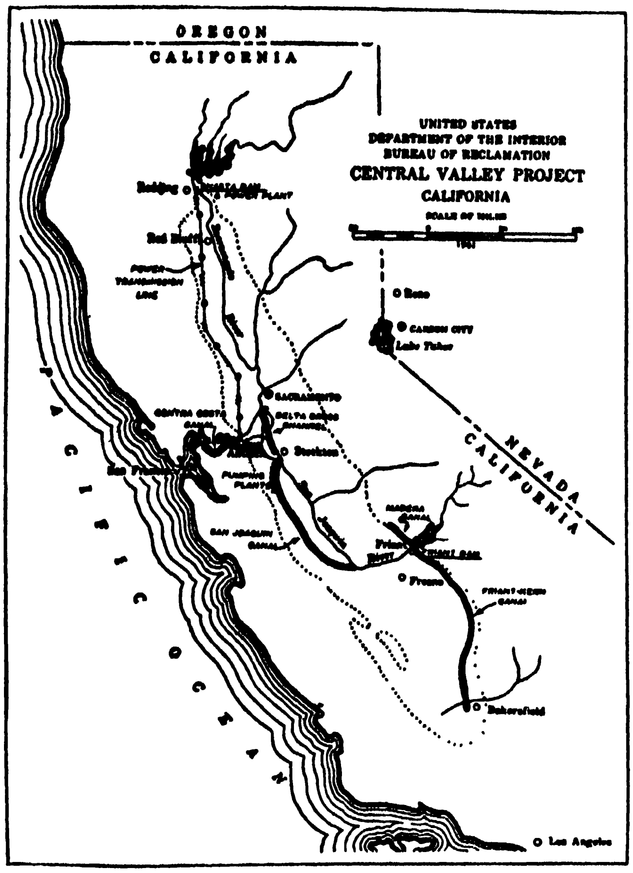
Beyond substitutions in this industry there is a definite trend toward simplification of containers of all sorts. Soon will be gone ornate wrappings on soap and similar products. Double paper coverings will be a thing of the past Possibly some industries will even turn attention to the design of packages which can be opened by the average person without the loss of at least a fingernail!

—*The Editors*

'Water, Water, Everywhere'

Multiple-Purpose Central Valley Project in California Involves Huge Dams, Five Canals

ANDREW R. BOONE



Area covered by Central Valley Project

From sky-scraping Shasta Dam on the north to Bakersfield on the south, beneficiary of water to be carried by canals stretching like tentacles up and down California's great Central Valley a total distance of 393 miles, it's a case of "Water, water, everywhere."

The United States Bureau of Reclamation looks upon the Central Valley Project as holding greater potential benefit, both locally and nationally, than any conservation project attempted in its 38-year history. This undertaking is a multiple-purpose project, involving construction of two huge dams, Shasta and Friant, and five canals, which jointly will:

Improve navigation on inland waterways, reduce floods in the Sacramento and San Joaquin River valleys, furnish water to irrigate 2,000,000 acres of highly productive agricultural lands, control salt-water encroachment in the delta region of the two rivers mentioned, improve domestic and industrial water supplies in central California, and develop hydro-electric power for municipal, agricultural, industrial, and project uses.

What the system of canals, and the water they will carry, mean to agriculture and industry may be noted in these facts and figures:

During the last season, ten times more rain fell at Kennet, in the northern end of the project, than at Bakersfield, near the southern tip. Kennet, in the future area of Shasta reservoir, which will back up 35 miles and impound 4,500,000 acre feet of water, received a total of 112.76 inches, while 11.61 inches (twice normal) fell at Bakersfield. Some of Kennet's surplus will flow into the north and central parts of the valley, and make available San Joaquin River water for diversion to the arid southern end of the valley.

Already, water is being delivered via the Contra Costa canal to Pittsburgh, an industrial city located in the upper bay region 40 miles east of San Francisco. Necessity for this supply arises from an increase in hardness of the local well water from 155 to 800 parts per million in 19 years, and difficulties of pumping against a head of 225 feet. Canal water is now being substituted for this and other pumped water.

Shasta Dam serves a far more important function than any other individual unit of the Central Valley project. "Shasta reservoir," explains Walker R. Young, assistant chief engineer for the Bureau of Reclamation, "will be operated to diminish the seasonal flood flows of the Sacramento River and thereby check annual waste to the sea of precious water, and correspondingly to increase the natural output of the river during dry months for purposes of navigation, irrigation, and salinity control. Reservoir releases will generate electric power to be carried by project transmission lines down the Sacramento valley to load centers. Finally, after the conserved waters of the Sacramento River have served all these functions and we have wrung the last squeal from the last drop, they will afford a surplus for export to the upper San Francisco bay region and San Joaquin valley through other features.

"These include the Delta Cross Channel to divert Sacramento River water across the delta, Contra Costa Canal leading from the delta westerly to a bayshore industrial and agricultural area, San Joaquin pumping system from the delta into the northern San Joaquin valley, and Friant-Kern and Madera canals to serve the southern San Joaquin valley. All these depend, directly or indirectly, upon Shasta Dam. In fact, no one feature can be fully utilized unless some or all the others are in operation."

Shasta—higher than Grand Coulee, second largest masonry dam ever built, with half again the mass of Boulder—staggers the imagination when you consider its proportions. Located 12 miles above Redding, on the Sacramento River, it will be 560 feet high and 3500 feet long. Six million yards of concrete will be placed before water climbs toward its crest.

Shasta will consist of a mass of pre-shrunk individual blocks, cooled by circulating river water through pipes imbedded in the mass. Upon completion of the blocks, they will be joined by pumping grout through another system of pipes, permanently imbedded for this purpose. Finally, a power plant, housed in a seven-story building, will involve operation of five 75,000-kilowatt generators turned by turbines developing 103,000 horsepower. The generators weigh 4250 tons, and 174 railroad cars will carry them from the manufacturing plant to the dam site. Of the 1,500,000,000 kilowatt hours of electrical energy developed each year, one-fifth will be utilized for project pumping, and the remainder made available for civil use.

Perhaps the most unusual feature connected with Shasta is the long aggregate delivery line. Were you abroad any morning in the vicinity of Shasta, say at 7:45, you would hear the combined blast of 30 horns stretching in a line 10½ miles long across the hills. And, were you standing alongside a small house at Coram, you would see an operator press a button starting a quarter-mile of loaded belting, known as flight 26, moving. In a few seconds, flight 26 would be up to speed, precisely six miles an hour, at which instant, flight 25 would commence turning. Six minutes after the button makes contact, all 26 belts, forming an endless delivery chain from the gravel plant at Redding, are rolling, carrying their load of 1700 tons of aggregate toward the hoppers at Coram By nightfall, 20,000 tons of material, the equivalent of 400 freight cars, will have been delivered.

Two conveyors at Redding alternately feed the main line. One runs under a huge sand pile, where it is loaded by several drawdown gates The other extends under gravel piles, for loading with different size gravel. The loading operator "ships" one size aggregate for one hour, then shifts to another. When a change is made, he 'phones the operator at Coram Exactly 88 minutes later, the Coram operator, noting a minute gap in the stream, notifies a shuttle operator to shift the delivery from one bunker to another, and delivery continues The shuttle conveyor is shifted quickly to any of five bunkers.

This conveyor has been spoken of often as being a "ten-mile belt" It really consists, however, of 40 belts. Aggregate in the first eight miles is lifted 850 feet in 22 flights. During the next four transfers, it descends 700 feet, the motors acting as generators to restore some of the power consumed on the long uphill climb At Coram, it starts another 14 flights for a 1.2-mile travel, at the end of which it goes through a 150,000-ton storage pile before being mixed with concrete and swung out over the canyon for placing in Shasta Dam. Total length of the 40 flights is 10 8 miles, and before Shasta is completed they will have transported 11,000,000 tons of sand and gravel to the site.

How concrete embodying the aggregates delivered along the belt line is placed represents certain engineering novelty. Flights seven to 14 of the second conveyor system transfer the aggregates from stock piles around and over the abutment to small storage bunkers at the top of the mixing plant.

This plant bears the appropriate name, "The House of Magic" During a single day's run, this plant mixes 10,000 cubic yards of concrete The order of mixing is fully automatic, and is controlled by four men The plant is hexagonal in shape, stands 130 feet high, and is fabricated of reinforced concrete and structural steel. At the top are five bins capable of storing 2165 cubic yards of aggregate, and two bunkers carrying 3200 barrels of cement. Following mixing, the cement is discharged into a hopper for the distribution cars, which operate on a circular track 420 feet in diameter This track circles the base of the head tower, and over it the concrete is carried to the various highline buckets.

Shasta Dam, conveyor belt in background

You'd have to climb 257 feet to reach the hoist floor In it you would find seven large three-drum hoists Lines from the hoist drums lead to the top of the tower and through sheaves to individual cableways Tail towers for the cableways are mobile, and operate on five radial runways. Each tower is controlled by an individual operator From his station, the operator can move the bucket out, lower it, trip it, haul it up, and bring it back for reloading. All buckets used on the high lines carry eight cubic yards, and are permanently attached.

Friant Dam, near Fresno, will be completed sometime in 1943. Aside from a certain measure of flood control, Friant will have little value until its connecting canals are open into areas of critical water deficiency, especially the 160-mile Friant-Kern canal, of 3500 second-feet initial capacity, under which more than half the service area of the Central Valley Project is situated

Friant presents a construction picture differing markedly from Shasta. No huge tower and cableways here. Rather, a giant trestle stretches from one side of the valley along the line being followed by the dam. Immense cranes, known as "hammer-heads," move along the tops of the trestle. From the cranes buckets of concrete are lowered. So high do the cranes stand above the valley they can continue handling the buckets until the dam is completed.

Friant's "house of magic," or mix-house, is located at one end of the trestle, and is fed with aggregates by means of a belt conveyor and cement through a pipe line similar to the Shasta arrangement. Railroad cars, each carrying four four-yard buckets are hauled from the mix-house along the trestle to the dumping area. There, cranes pick up the buckets singly, raise them in an arc to the dumping point, and return them to the cars. By this means, 5000 cubic yards of concrete are placed daily

Like Shasta, Friant offers some new construction methods and practices. It is smaller than Shasta, yet a whopper in its own right. Friant will be 320 feet high and two-thirds of a mile long. With 2,200,000 cubic yards of concrete finally in place, it will be exceeded in size only by Grand Coulee, Shasta, and Boulder.

On the downstream face, which will be exposed to weather except during brief periods of overflow, an absorptive lining is used in the forms. This material is quite porous, and has the property of soaking up water as the concrete is poured, causing the surface to become more dense by drawing fines to the surface. Because the surface is denser, it will resist weathering longer.

The Central Valley Project not only will insure water for California's lush agricultural production It also will restore thousands of acres lost in recent years to production because of water scarcity, and guarantee water to such defense industries and military establishments as may spring up in this region. All together, it represents a mighty effort at conservation which bids fair to yield tremendous returns in many fields.

New Pleiades

Recent Investigations of Proper Motions Have Added Two Dozen More Stars to the Famous Cluster

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University, Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

ONE of the most conspicuous objects in the sky is the cluster of the Pleiades. The brightness of its stars and their apparent closeness set it apart at a glance, and it was doubtless recognized long before the Greeks gave it the name by which we still know it.

Six stars are easily seen by any normal eye; keen eyesight may raise the number to eight, or even to ten. A field-glass shows dozens, and telescopes reveal numbers steadily increasing with their power. With a modern instrument, of high light-power, it would be easy enough to photograph 10,000 stars within two degrees of Alcyone—the brightest star of the group.

But, if we pointed such a camera to any other part of the sky and made an exposure of equal length, we would find a great number of stars on an equal area of our plates The sky is full of faint stars everywhere, and there can be no doubt that our photograph of the Pleiades region must show a host of "field-stars" which have no connection with the cluster—most of them lying far behind it, and a few probably in front. How can we allow for this? The presence of the cluster should make no difference in the distribution of the stars seen in front of it or through it. We may expect to find the same number of field-stars per square degree as in other regions of the sky. Any excess (over and above the fluctuations reasonably attributable to random sampling) may be ascribed to the cluster.

For example, Trumpler, counting the stars of the Bonn Durchmusterung—which goes down to about the tenth magnitude—finds, for the number of stars in the vicinity of the Pleiades:

Distance from Center	Number	Number per square degree	Field	Cluster
0°—1°	63	20.0	12	51
1°—2°	56	5.9	36	20
2°—3°	79	5.0	60	19
3°—4°	87	4.0	84	3
4°—5°	104	3.7	108	(—4)

The number of stars per square degree, in the successive zones, falls off to a nearly uniform value of 3.8, which may be taken to represent the "field." If this was uniform, the number of field stars would be as given in the column captioned "Field." The excess of the actual numbers should represent the cluster members. The values 3 and —4 for the two outer zones are evidently due to random irregularities, but it is evident that the Pleiades cluster stars extend to about three degrees from the center. Within this region there are 90 cluster stars, and 108 field stars—with a probable uncertainty of not more than five.

BY such counts it becomes certain that. among the fainter stars in this region, we must have hundreds of cluster-members, mingled indiscriminately on our plate with a larger number of wholly unrelated ones. To separate the two would be a thankless task, were it not for one fortunate thing. The Pleiades cluster is not at rest in the heavens. The brighter stars, which have been very accurately observed, are moving, slowly but definitely. Measures of their relative positions, made long ago, with the heliometer (then the most accurate instrument) and later by still more precise photographic methods, show that they do not change their distances and directions from one another at any perceptible rate, while the meridian observations reveal a motion of the whole group together southward and eastward, at the rate of $4''.8$ per century.

This is a rather slow motion for stars as bright as the leading members of the group; but in 20 years it displaces the cluster by almost a second of arc. Measures of a single good photograph will locate even very faint stars with an error less than a tenth of this. So the astronomer who is lucky enough to have an old plate of the Pleiades need only take another—with the same telescope and of just the same region—measure the star-images on both, and apply the simple corrections which allow for the fact that the two plates were not put into the measuring-machine in exactly the same position. The great bulk of the fainter stars will show little or no change of position in 20 years—they are too far away The nearer ones (and a few more distant ones whose actual velocities in space are great) will have moved, compared with the rest. Those which belong to the cluster will have moved by the amount and in the direction which follows from its known yearly motion, and can be picked out by simple inspection of the list.

By sheer luck, a star or two out of the hundreds on the plate might appear to be moving in this direction and at this rate, though not really connected with the cluster, and so might get into the list where it did not belong. But this demands a double coincidence of direction and rate of motion, which is very improbable. The fainter the stars considered, the slower their average proper motions will be, and the smaller the probability of such an accident.

EVEN the best observations cannot be perfectly accurate, hence the final list has to be divided into three classes—stars whose observed motion agrees so closely with that of the cluster that it is almost certain that they belong to it; stars for which the discordance may arise from an accidental heaping up of the errors of observation, and which are "probable" members; and those for which the discordance exceeds any reasonable allowance for these errors—which are dismissed as non-members. The majority of these will be slow-moving background stars—seen through the cluster. A few, which move faster than the cluster, or in different directions, may lie in the foreground, or at more or less the same distance but do not belong to it.

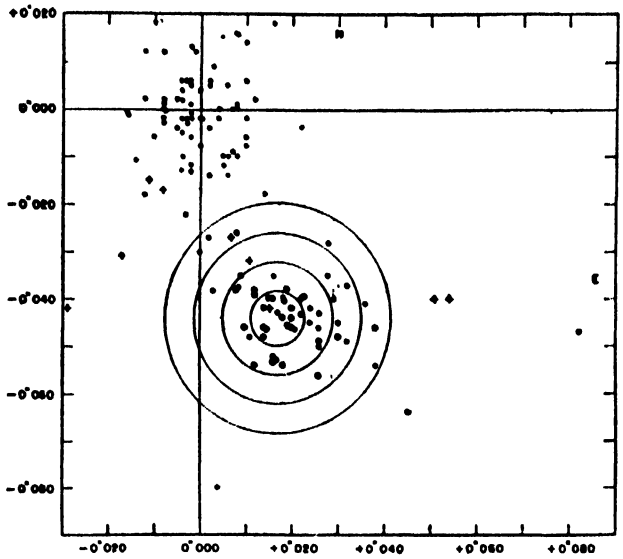
Trumpler, in 1921, and Hertzsprung, in 1929, applied this method to the Pleiades. The latter listed 187 cluster members in a region two degrees square centered on Alcyone—some of them as faint as the 16th magnitude. The question whether still fainter stars—and how many—might be present could be answered only by long exposures with great telescopes This has just been done by van Maanen at Mount Wilson. A few plates of the Pleiades had been taken with the 100-inch telescope in 1921 and 1922—covering a field 42 by 31 minutes of arc, with Alcyone in the center, and showing images of stars down to below magnitude 17.5—about 800 of them in this small area of little more than one third of a square degree. The best of these plates, compared with some lately taken, gave two pairs with intervals of 15 and 19 years, upon which the motions of stars belonging to the cluster would be conspicuous. Indeed, when the earlier and later plates were "blinked" with the stereocomparator, 70 stars out of the 800 were found to have moved perceptibly. All these, regardless of their direction or rate of motion, were measured. It would have been an obvious waste of time to measure all the 730 other stars, only to get no perceptible motion. Sixty-seven of them—distributed evenly in position over the plate, and in magnitude between 13 and 16.5—were chosen as comparison stars, and sufficed to define a distant and substantially motionless background.

Of the 70 moving stars, 39 showed motions so nearly identical with that of the brighter stars of the cluster that their membership in it was practically certain; 9 others agreed well enough to be recorded as probable members, 8 were doubtful, and 14 clearly did not belong. Six of the latter turned out to be moving slowly, and probably were members of the background, while the other eight moved as fast as the cluster or faster, but in other directions or at other rates.

In this small area, then, there are almost certainly 39 and probably 48 cluster stars. This includes 26 previously identified by Hertzsprung; hence the inclusion of stars about two magnitudes fainter has nearly doubled the number. If the same proportion holds for the regions not yet photographed with the 100-inch, there must be about 350 cluster members in the two degrees square, and very likely 800 in the whole cluster, which extends beyond this but thins out rapidly.

There is no sign at all that the limit of faintness has been reached. Including the "possible" cluster members, there are 13 stars in the well-observed area between magnitudes 6 and 10; 10 between 10 and 14; and 31 between 14 and 18 with the last count incomplete.

It would be a conservative guess to say that there must be at least 2000 stars in the Pleiades cluster, and that fully half of them are too faint to photograph with the 100-inch telescope—but of course this *is* a guess.



This diagram shows the rates of motion of the stars in the Pleiades observed by van Maanen. Imagine a set of points, each starting at the intersection of the lines marked 0.000, and each moving at the same rate and direction as one of these stars. At the end of a year they would present the appearance shown in the figure. The comparison stars (represented by the small black dots) are very remote, and move very little—indeed, their scatter about the starting point arises mainly from the small errors of observation. The large group of dots lower down and to the right represents the members of the Pleiades cluster which (within the errors of observation) are moving together. The black dots represent stars previously identified by Hertzsprung; the open circles, those found by van Maanen. Points inside the inner circles indicate almost certain members of the group; the next circle includes the "probable," and the last, the "uncertain" members. This group of points is almost completely separated from the one which corresponds to the "background" stars, and provides conclusive evidence of the existence of a moving cluster in this region. The small circles elsewhere in the diagram indicate "foreground" stars of relatively fast motion. From *Astrophysical Journal*

The distance of the cluster—though too great to measure directly—is fairly well determined by a study of the absolute brightness of its stars, and appears to be 400 light-years. On this basis, the faintest cluster stars so far observed have an absolute photographic magnitude of +12—which means that they give out about 1/400 as much violet light as the Sun.

Hertzsprung has found that the faint cluster stars are all red, and redder the fainter they are down to his limit of observation at the 14th magnitude. The newly discovered members are doubtless still redder, typical faint dwarfs of spectral class M, running down to about 1/150 of the Sun's visual brightness.

Alcyone is 2000 times as bright as the Sun (photographically) and almost a million times brighter than its faintest known associates in the cluster. As in similar cases, this enormous difference doubtless arises from the concurrent operation of several factors. Alcyone is more massive, larger, and, above all, much hotter on the surface than its tiny neighbors. All but the brightest of the Pleiades appear to be normal main-sequence stars—heat-engines working in the same way and deriving their energy from the slow transmutation of hydrogen into helium by means of the now well known "carbon cycle."

Alcyone and a few others are abnormally bright for their spectral type, and their internal composition or constitution must be somewhat different. Unfortunately, none of these bright stars is double, and we cannot therefore find their masses, which might give us a clue to the reason for their peculiarities. There are several double stars, with slow orbital motion, among the fainter cluster members, and these appear to be of normal mass for their brightness.

To study still fainter stars, we must leave distant systems like the Pleiades, and search among the nearest stars. These are still being picked up, as parallaxes are measured for the faint stars of large proper motion which are detected by systematic "blinking" of pairs of plates taken years apart.

There is still good hunting for the observer here. Dr. van Maanen, reporting on his last 25 parallax fields, finds eight stars—one of them double—within 50 light-years. Four of them are less than 30 light-years away, and two of these are really our near neighbors, with distances 10.3 and 11.2 light-years. These stars, like almost all faint ones, are known only by their numbers in the catalogue of the observer who discovered their motions—Ross 128, of magnitude 12.7 and Luyten 789-6 of magnitude 14.3. The second—and nearer—of the two is noteworthy as having the largest proper motion of all the stars found by Luyten in the great survey which he has made. Its motion of 3″.27 per year is exceeded by some 15 other stars, but none of these is as faint. The absolute magnitude +16.8 indicates that its photographic brightness is but 1/30,000 part of the Sun's, while its spectrum M6 marks it as one of the coolest dwarf stars which has ever been observed.

Shockless Surgery

Ice Anesthesia, Boon to Aged in Limb Operations and a Promise for War Wounded in the Field

BARCLAY MOON NEWMAN

Just in the nick of time, for use in saving the lives of thousands of war wounded—civilians injured in air raids and soldiers on the battlefield—comes a revolutionary technique in surgery. Bloodless, shockless surgery, without any other anesthetic than cold, has been developed by the New York diabetic specialist, Dr. Frederick M. Allen.

Also, for the first time in medical history, we have anesthesia of the whole living tissue substance, instead of the former crude anesthesia of nerves alone—hence a remarkable freedom from pain and from deadly shock.

Infection is rendered far less likely.

Emergency cases with shattered limbs can be painlessly, bloodlessly, shocklessly, transported great distances and, if necessary, kept waiting safely for many hours before operation; ice bags, a pail of cracked ice, or a special refrigeration apparatus, as well as a tourniquet, is all that is needed.

The patient is ready for immediate operation any time after the limb has been thoroughly chilled, without further ado, without even a local anesthetic

Here is a veritable boon for China, for Russia, or on any battlefield where anesthetics, antiseptics, drugs, may be lacking, a boon, too, for the aged diabetic or sufferer from hardening of the arteries who must undergo operation for gangrene of the foot. More of the arm or leg can be saved, in young or old, than with the old techniques. More successful are the operations, which formerly, with the old techniques, were accompanied by a rather high mortality.

Though the first extensive trials were reported only within the past few months, this new "cold surgery" and "protoplasm anesthesia" are already adopted as routine in many hospitals, with City Hospital, New York, showing the way. At City Hospital, Dr. Lyman Weeks Crossman, Dr Wilfred Ruggiero, and Dr. Vincent Hurley have used the new surgery in scores of gangrene cases, with such a high percentage of successes that the attention of the medical world has been attracted

Most astonishing to the layman—and to many a surgeon, too—is the fact that a patient can eat breakfast while his wounded or gangrenous leg is being painlessly cooled to a few degrees above freezing, then can go into the operating room without further anesthetic or any drug whatsoever, chat with the nurse while the surgeon amputates behind a screen, and can return at once to the ward and eat a full lunch, as though nothing had happened. There is no pain, no shock—hitherto a great cause of weakness, and often of fading vitality long after such major operations

Limb immersed hour and a half or more in ice water, cracked ice

In war wounds and in other emergency cases, where a limb operation or amputation is necessary, a rubber tube is used as a tourniquet to shut off the circulation, the degree of tension being just sufficient to stop all blood flow to the lower portion of the leg or arm. "The rule that a tourniquet cannot be applied to a diabetic or arteriosclerotic limb is set aside by cold," Dr Allen points out, to the amazement of surgeons skilled in the older, very ticklish handling of gangrene in aged diabetics or others with poor circulation in the extremities. Then, the leg or arm is immersed in ice water to a level about one inch above the tourniquet. Weaker patients may lie with only a slight elevation of the head of the bed and, with the protection of a rubber sheet, the leg is placed on a layer of ice and then is covered completely with cracked ice. Or, again, rubber ice-bags may be used, salt being added to each. The newest development is an electrically refrigerated "blanket."

A 200-pound refrigerating apparatus serves four to six patients simultaneously, and can readily be fitted into an ambulance. Thus emergency cases can be prepared for operation en route—in fact, are out of pain, unshocked, uninfected, even unstrained in the meanwhile The dual application of tourniquet and cold brings almost immediate, complete loss of sensation in the injured limb The rest of the body can be kept as warm as desired. There is no general chilling above the tourniquet

In ordinary hospital routine, where the case is one of gangrene and there is no bleeding, the limb may be first surrounded with a few ice bags at the level chosen for the tourniquet. Within five to fifteen minutes the skin is chilled so that the application of the tourniquet causes practically no discomfort A preliminary morphine hypodermic or other sedative is sometimes used in instances where the patient is nervous and apprehensive, but otherwise no anesthetic or other drug is needed

Tests of the refrigeration are made by means of a thermometer held next to the skin. The desired temperature is about 40 degrees, Fahrenheit, eight degrees above the freezing point of water. This assures adequate chilling without risk of actual freezing

"The time required for complete through-and-through anesthesia varies with the depth of tissue," Dr. Allen states. "It may possibly be as short as one hour for an emaciated shin, or as long as five hours for a rather thick thigh." Then, with the patient in the operating room, the limb is removed from its nest of ice bags or other refrigeration. Sterilization and operation are carried out as usual. The surgeon need not hurry. the chilled tissues stay cold long enough for an ordinary operation, and longer. For extraordinarily lengthy operations, the limb may be kept on a bed of ice bags. When the operation is complete, the tourniquet is released, blood rushes in, and any bleeding points are quickly caught and stitched up.

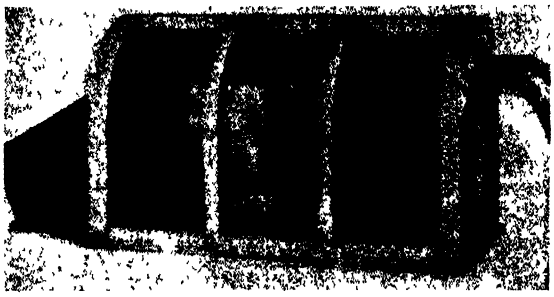
The surgeon has had the opportunity

of working in a bloodless and shockless field. Shock is at most that slight degree which may develop from the tissue injury left after the wound is finally closed and the temperature raised to awaken the "hibernating" life substance, protoplasm.

After the operation, the patient has neither nausea nor gas pains, so common in ordinary anesthesia. The practically complete absence of shock is evidenced by a steady pulse, constant level of blood pressure, steady rate of respiration—no changes occur during or after the operation. This is ideal for surgery of those who are so weak that ordinary operative shock would likely be fatal. In a series of more than 50 operations reported on at City Hospital, the average age was 68, and a number of these patients were four score years old. Almost all were suffering from heart disease, or diabetes, or hardening of the arteries, yet they successfully underwent the hitherto risky major operation of amputation Formerly, four out of five died, when operated on by the older procedures In the City Hospital series of cases four out of five lived.

Not only shock but bacterial infection plagued the older surgery. We all know that refrigeration prevents the growth of bacteria. Doctors are all familiar with the preservation of living tissue in the ice box for weeks and even months—alive and uninfected. In cold surgery, as well as in the transportation of refrigerated wounded to the hospital, bacteria simply cannot grow

After amputations, there is the ever-present danger of blood coagulation, sometimes extending rapidly up a limb and entailing a correspondingly rapid gangrene. Such phenomena are caused largely by damage of the blood vessel walls. Bacterial invasion may bring about the damage In arteriosclerosis, damage to the walls arises from lack of nutrition and of oxygen, as well as from bacterial action Now the clotting is prevented by cold, which preserves the vessel walls. Parts which have deficient circulation can be most effectively chilled and, by very gradual warming through several days after the operation, survival of the tissues is promoted. In ordinary cases under the new procedures, gradually lessening refrigeration is the rule, the manipulation of ice bags permitting a slow return to normal temperature. The wound margins can be kept healthy, yet not sealed Discharge may continue abundantly It cannot decompose or become infected, because enzymes and bacteria are checked by low temperature



Electric refrigerator cradle for treatment of extremity — hand or foot — at low temperature

Of course, as Dr. Allen says, healing is slowed in proportion to the reduction in temperature But there are advantages here, too. A whole series of important new controls become available when needed When there are threatening signs of loss of vitality in wounds, the surgeon has previously had to stand helplessly by and watch the wound slough. The sloughing is due to deficient nutrition and oxygen. Now it is possible to reduce the tissue metabolism (use of food and oxygen) to a level for which the existing blood supply is adequate.

Ice-immersed extremity of patient lying in bed. Complete anesthesia in two and one half hours

The use of low temperatures opens up other striking possibilities — already realized in the hospital. In the most desperate cases, hitherto, surgeons have had to take the risk of a high amputation if the patient is to be considered operable at all. Such has been the situation in severe gangrene of the exhausted aged, diabetic, arteriosclerotic, and in rapidly advancing infections of the limbs of young or old. Refrigeration offers an alternative, and the tourniquet can add all the advantages of operation without the shock. The advance of infection, the pain, the downward trend of the patient, can be checked for several days by simple packing in ice.

To anesthetize, thermostatic controlled refrigerator keeps "blanket" at 40 degrees, Fahrenheit

Transfer of all these results to war conditions offers much. It offers the hope of transportation of limb casualties without hemorrhage, pain, or shock; without advance of infection or tissue devitalization; with minimum damage and maximum time limits of tourniquet application, and with freedom to operate without an anesthetic or to delay for several hours according to the exigencies of a crowded surgical service.

With regard to its practicability in war, refrigeration is usually available on naval vessels, and for modern mechanized armies the 200-pound apparatus is obtainable. This can be operated by the motor of a truck or ambulance and can refrigerate four to six limbs simultaneously, while ice is frequently available in less fortunate countries, from Finland to China, where the lack of anesthetics has entailed much suffering

A large number of both military and industrial wounds consist of mutilations of limbs. In warm weather ice is often available or can be especially provided. In cold weather, only precautions against actual freezing of parts may be needed The chilling is so simple that it can be carried out by reasonably intelligent non-medical persons. The tourniquet, of course, is necessary to stop hemorrhage, and under appropriate conditions of reduced temperature may be kept in place for several hours without risk The transportation of wounded persons can be made entirely painless, as far as limb injuries are concerned. There is probably better preservation of strength and resistance than with large doses of sedatives. The wounded may then arrive at a hospital after several hours, ready for immediate operation without any additional anesthetic.

Even when any parts are potentially infected, perhaps by being contaminated with dirt and other foreign material, refrigeration holds everything in abeyance. The preservation of tissue vitality and resistance to infection should facilitate conservative and reparative operations and aid in avoiding amputations and crippling. Much more of the limb may thus often be saved, or even whole limbs that would under the older procedures have been necessarily removed.

These achievements are indeed revolutionary. So much so that they might not yet have gained recognition except for the courage and vision of Dr. Allen's colleagues, Dr. Crossman and his associates, in applying them on a scale sufficient to convince other surgeons. The greatest obstacle was and still is lack of financial support. As Dr. Allen has written: "The only support for this research has come from the American Medical Association, in the form of a $500 grant from its Committee on Scientific Research, for animal experiments, now conducted at the New York Medical College, and one of $300 from its Council on Physical Therapy, for the clinical study at City Hospital in New York."

Except for these obstacles, there need not have been the long delay since the report of the first human cases in 1937, and the world-wide adoption might have been possible before the outbreak of the present war. It might have been the means of saving the lives of soldiers and civilians the world over.

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AGAIN GUILTY?

Do Flies also Spread Infantile Paralysis?

The case against flies as the culprits that spread infantile paralysis is strengthened by a discovery reported by Dr. Albert B. Sabin and Dr. Robert Ward, of the Children's Hospital Research Foundation and the University of Cincinnati College of Medicine, in the current issue of *Science*.

Flies caught in Cleveland and Atlanta in the neighborhoods of infantile paralysis patients were infected with the virus of the disease. Previous discovery of the infantile paralysis virus in flies was made in insects trapped in rural areas, in one instance near a privy used by three households in which there were infantile paralysis patients.

Discovery of the virus in city flies is considered more significant, especially since the infected flies were found in modern neighborhoods with good plumbing and in which several children had mild illnesses that might have been abortive infantile paralysis at about the same time other children had recognized attacks of the disease.

Flies as carriers of the disease fit with the theory, suggested by recent evidence, that the virus attacks through the alimentary or digestive tract rather than through the olfactory nerve from the nose. Suggestive also is the fact that the fly season and the infantile paralysis seasons coincide.

PRONOUNCIATION

Of Names of Two of the Sulfa Drugs

Not laymen alone, but physicians also, have differed widely in the pronounciation of the words sulfanilamide and sulfathiazole, two of the sulfa drugs. *The Journal of the American Medical Association* now states that the Council on Pharmacy and Chemistry of the Association has recommended that the word *amide* be pronounced with the long *i* (amīde). Thus it rhymes with chloride and iodide. In the word sulfanilamide the syllable *il* is given the major accent.

Sulfathiazole is to be pronounced similarly with a long *i*, and the accent on the *thi.*

INFECTION

Depends on Both Bacteria and Host

Like the modern blitzkrieg and its aftermath, extremely virulent bacterial infections actually are ineffective from the standpoint of the bacteria, as parasites, because the microbes so rapidly destroy the tissues upon which they live and grow, according to Dr. Paul R. Cannon, professor of Pathology at the University of Chicago.

Time plays a commanding role, in infections, as important in the incipient stages as it is in a beginning forest-fire, said Dr. Cannon, continuing:

"The ability of bacteria to grow in living tissues depends upon forces inherent in both the bacteria and the host.

"At times, with highly virulent bacteria, this ability to grow is so predominant, that, under proper conditions, they can multiply rapidly, metabolize efficiently, and overcome quickly all efforts on the part of the host to prevent these actions. This type of infection, fulminating in development and quickly lethal in course, represents the maximal biologic growth efficiency of the bacteria concerned."

A return of scourges like the "Black Death" cholera and typhoid fever today is not so threatening as it was when these diseases ran riot in Europe, Dr. Cannon said, because of modern methods of keeping invading bacteria localized, and their toxic action checked until they can be destroyed by the defensive forces of the body.

PREGNANT?

Electric Recordings of Unborn Baby's Heart Beats

Electric recordings of the heart beats of an unborn baby can now be made successfully for practical purposes by means of a technique announced by Dr. Arthur J. Geiger, Dr. Willys M. Monroe, and Dr. Allan V. N. Goodyer, of Yale University School of Medicine, in the *Proceedings of the Society for Experimental Biology and Medicine.*

Doctors have tried for years, hitherto with only indifferent success, to obtain electrocardiograms of the unborn baby's heart beats, although these graphic recordings of the electric current produced by the heart muscle contraction have long been used in studying heart disease.

The new technique, the Yale investigators report, enables the doctor to tell promptly whether a woman is about to become a mother or whether she has a tumor. It does not give "false positive" results and takes less time than mouse or other biological tests for pregnancy.

"Will it be twins?" can be answered much earlier than by any other method of examination.

In their work the Yale doctors use a single stage resistance-coupled amplifier with a conventional portable electrocardiograph. The electric current accompanying the unborn baby's heart beats is picked up by disk electrodes placed on the mother's abdomen. They are amplified 20 times, which brings the recording into plain view, and the apparatus is arranged to minimize pickup of the mother's electrocardiogram. The small 12-pound amplifier of standard radio parts is simple to operate and can be easily carried with the electrocardiograph.—*Science Service.*

Torpedo!

Mechanics of the "Tin Fish" That is Writing a Terrifying Record of World-Wide Destruction

DONALD WILHELM

A TANKER, northbound with a cargo of oil, plows heavily through the Atlantic swell a few miles off Long Island. Suddenly the ship staggers as though from the blow of a titanic fist. A rending explosion rips open her side, and a torrent of water pours through the hole into the hull. Five minutes later she is awash. Then her bow slides under the waves. The stern tilts up, and she plunges to the bottom. A U-boat has struck again with the deadliest of modern weapons—a torpedo—against which the naval engineers have found no satisfactory protection.

Official U S Navy Photograph

A "tin fish" takes to the water for test

Just what is this blasting hellion of the deep, this streamline horror called a torpedo? It is the most intricate and perfect engine of destruction which scientific military design has yet produced. It is the smallest warship afloat; 24 feet long. For it *is* a ship, complete in every detail. It has a wheel house, an engine room, a cargo, and a crew to steer and run it; a mechanical crew more precisely obedient than any human sailors. It takes and holds, exactly, the direction assigned its mechanical brain If so directed, it will describe a complete semicircle before settling down to its course; or it will plunge ahead point-blank in the direction it is launched. It will travel precisely at the depth desired under the surface of the water. And it never wavers. Like a big battleship, it is given test runs and tried for any faults it may have before it joins the fleet.

A 3000-pound "fish" of steel with 600 pounds of high explosives in its warhead, it knifes through the depths at nearly a mile a minute, driven by more than three times the power of a V-8 car at full throttle. Without warning, it hits its victim with a blasting wallop which staggers even the heaviest battleship afloat. Britain's "unsinkable" *Prince of Wales* and Hitler's vaunted *Bismark* have succumbed to its sting

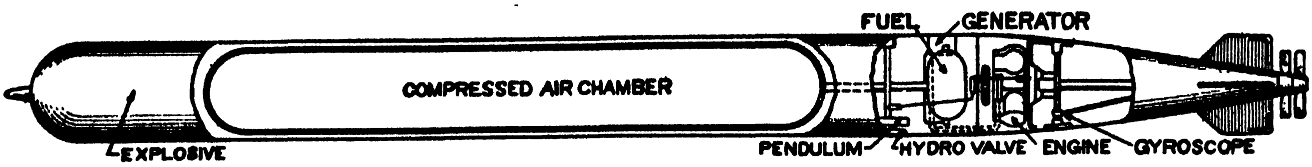
Naval architects have tried every device they could think of to defeat the torpedo "Torpedo bulges"—double hulls, constructed in the hope that the torpedo would explode between the outer and inner shells and not penetrate the ship's vitals—were tried and abandoned. Battleships are now divided into many compartments, so that if one is blasted by a torpedo, the others can be shut off from the inpouring water. But even these precautions are generally ineffective. The impact of a 16-inch shell is light by comparison to that of a torpedo. As Admiral Hart said recently: "When a torpedo hits anything, it stays hit"

This vicious little robot, capable of scuttling a vessel 20,000 times its weight, has made history in every naval engagement since the Japs sailed into Port Arthur in 1904. It nearly changed the outcome of the first World War, accounting for 2000 ships, totaling 6,000,000 tons. It was fear of torpedoes that kept the British from following up and destroying the German navy at Jutland. In the evil month of April, 1917, it cost the Allies nearly a million tons of shipping, a rate that soon would have stopped the beating of England's heart Today Hitler is gambling on the torpedo to rupture the communication lines on which the Allied effort depends. Once again German U-boats lurk off our shores, waiting to send destruction—via torpedo—to the next vessel that comes within range.

Like most first-rate scientific achievements, the modern torpedo is a result of a long series of experiments, some of them abortive. Ever since ships first began fighting with gunpowder, naval men have sought means of bringing a large explosive charge against their enemies' hulls. In 1776 a scheme was proposed, but never tried, for breaking the British blockade of American colonies by approaching King George's men-of-war from under the water and fastening bombs to their bottoms. Later, Robert Fulton discussed with the governments of France and England his ideas for an underwater attack. The first torpedo actually to see service was the "spar torpedo" of the American Civil War This contraption, a long ram with a bomb on the end of it, was a sorry forebear of today's "tin fish," but a terror in its day.

The torpedo as we now know it was born in 1864, when a Captain Luppis of the Austrian Navy went to the famous Scottish engineer, Robert Whitehead, with a plan for a self-propelled, self-steering underwater projectile. Whitehead, fascinated with the idea, began work at once, in a little shop in Fiume. Two years later the first Whitehead torpedo slid into the water—and worked. It was a crude little machine, only 10 feet long, traveling seven miles an hour by compressed air, and carrying 19 pounds of guncotton in its head But it was the daddy of them all So sound was the great engineer's work that his basic design has changed but little. Speed, size, and explosive power were increased, however, and by 1914 it was the most dreaded weapon on the high seas. With World War I, the torpedo came into its own.

THE early torpedo was notoriously tricky; even during World War I it was still a dangerous weapon to handle. So erratic was its course that it often menaced the mother ship more than the target; several German U-boats were blown up by their own torpedoes. They had other quirks. They left a wake of bubbles that betrayed the location of the mother vessel and often led to its destruction They often jumped out of the water like porpoises. One U-boat commander's experience became a classic Cruising on the surface, he was suddenly attacked by a



General arrangement of torpedo mechanism: Exact details are military secrets

British submarine. The Englishman fired a torpedo. The German saw it coming too late; he had no time to turn his sluggish craft, and stood awaiting his inevitable end. But as the torpedo was about to strike, it leaped out of the water, slithered across the U-boat's deck, and plunged harmlessly into the sea on the other side.

The torpedo of today—and the designs of different nations vary only in detail—has none of these vagaries. The world's navies have lavished the best brains available on getting the "bugs" out of it, made it so powerful it can knock a hole in the side of a cargo vessel even without its explosive head, so accurate it can run for miles without appreciable deviation from its set course and depth, so destructive that no ship that sails is safe from it. Its active life is short, ranging from a few seconds to six or seven minutes. When it misses, it runs for about eight miles, then automatically sinks, so it cannot be a navigation hazard or fall into the hands of the enemy. Its mechanism, comprising 3000 precision-built parts, is as intricate as that of a watch. To make one requires some thousands of man-hours of labor and $12,000 in cash. Foot for foot, pound for pound, it is the most expensive of all naval vessels. But it is the best investment any navy can make. Its one and only service voyage may decide the fate of a nation.

From bow to stern, the torpedo's 24-foot length is divided into four main sections The first is the warhead, built like an armor-piercing shell containing 600 pounds of the most devastating explosive known. Behind the warhead is a large compartment holding compressed air, its main driving force, under the colossal pressure of 2800 pounds per square inch—several times the maximum in the most powerful locomotive boiler. Behind that are smaller tanks, in which the torpedo carries its own fuel, water, and lubricating oil. Another section is the "engine room," where the mechanical brain that guides the torpedo and the engines which drive and control it are housed. Finally, there are the twin propellers, revolving in opposite directions (a single propeller would only make the torpedo revolve in the water) and the two sets of rudders, one for direction, one for depth.

Torpedoes are launched from the tubes of submarines, the decks of surface vessels, or the bellies of airplanes —it's all the same to the torpedo. For it is every inch a seagoing vessel; once in its element—the water—it's a warship on its own. The duties of a launching vessel and its crew are merely to get the torpedo somewhere within five miles of its target (the closer the better), give it its orders, and get it started. In submarines, this is done by a blast of compressed air which pushes the baby vessel out of its tube. In the deck-tubes of surface vessels, a small explosive charge boosts the torpedo over the gunwales and into the water. Airplanes merely drop them.

When a torpedo is discharged, an amazing number of things begin to happen inside it, in an incredibly short time. A starting lever, tripped by the missile's forward movement, opens a valve, and a blast of compressed air starts the main engine. Another unit provides a highly inflammable fuel spray. Two slow-burning cartridges explode, go on burning like candles, to ignite this spray. In the same split-second an ingenious self-starting, self-regulating water-pot begins spraying water on the flame. Only a few feet away, remember, is 600 pounds of high explosive. The water-pot supplies water to make steam and, by regulating the volume of its spray, keeps the temperature in the fire-box exactly at 1250 degrees—no higher. The steam-gas-compressed-air mixture slams into the main engines with such force that 400 horsepower is instantly generated, quickly driving the torpedo's speed up to nearly a mile a minute.

Even more ingenious is the mechanism which guides the deadly "fish" on its swift little voyage. Just before it is launched, a torpedoman—on instruction from the fire control officer who has computed the position, speed, and range of the target—sets its direction and depth by adjusting a small, numbered spindle, like a radio dial. It is no longer necessary to aim the torpedo dead at its target. Whatever direction it may be launched, the mechanical "fish" will return to its set course before it settles down to its final straight run—a big help for the destroyer which does not want to turn its side toward the enemy and present a big target while firing its deck tubes.

The principal member of the torpedo's mechanical "crew" is a gyroscopic pilot. It is a bronze flywheel, the size of a teacup saucer, which is set whirling at 18,000 revolutions a minute by a jet of compressed air. Connected with this gyro-compass, and controlled by it, is a small engine, which operates the directional rudder. The gyroscopic pilot instantly corrects—through its engine and rudder—any deviation of the torpedo from this course. It never makes a mistake.

A torpedo must also hold to a second course, depth—usually about 15 feet below the surface. When hurled from a plane or a deck tube, it must not dive as deep as its immense weight inclines it to; it must not lunge out of the water like a tarpon on a line, or lose speed by gambolling up and down as torpedoes used to do. Its underwater course must be kept level. Another mechanical brain takes care of that. A sensitive pendulum and a hydrostat, which measures the depth of the torpedo by external water pressure, control a second small steering engine, which operates two horizontal rudders in the tail. If the torpedo is running closer to the surface or lower in the water than ordered, the rudders steer the "fish" down or up, until it is at the correct depth All these mechanisms are fitted tidily within the torpedo's slim diameter—21 inches!

The "tin fish" used to leave a wide, tell-tale wake of lively white bubbles from the cold compressed air which streamed out its exhaust pipe. This sometimes gave the victim time to dodge the oncoming torpedo, and marked the position of the submarine which fired it. The modern torpedo leaves almost no wake. After the blazing, white-hot mixture of compressed air and steam has driven the torpedo's engine, it is exhausted through the hollow bronze propeller shaft. The steam, on striking the cold sea water, condenses, turns back into water; the hot air forms tiny slow-rising bubbles which cannot be seen from any distance. The "tin fish" is noisy, and can be picked up on sound-detecting devices, but seldom in time. It gives no warning and leaves no trace.

The deadly torpedo has already written a fearful record of destruction in World War II—the *Prince of Wales*, the *Repulse*, the *Bismark*, the *Ark*

Royal, the *Reuben James;* Taranto, Cape Matapan, Pearl Harbor; the Battle of the Atlantic, of the Mediterranean, of the Pacific. U-boat operations off our coasts indicate a new phase of torpedo warfare of unprecedented ferocity.

Before we entered the war, watchers reported that the big ship yards at Kiel, Bremen, and Hamburg had switched from big warships to small surface raiders and submarines. At Danzig and Stettin, large new submarine plants have been put up, and the torpedo school at Kiel has been enormously expanded. The United States Navy can play at that game too. Our own Torpedo Stations are humming as never before. Torpedoes used to be made almost exclusively in plants owned and operated by the Navy. Today scores of factories are working on confidential sub-contracts, turning out torpedo parts in an immense speed-up of their production.

The Battle of Macassar Straits has shown that we are as good at torpedoing as the Germans, if not better. The Japanese have learned that it is risky to move troops past the tubes of American torpedomen who traditionally pat their "tin fish" on the rump before they are loaded, care for them with the love of fine machinists for fine machinery, and dispatch them with an accuracy unparalleled by any other navy.

The decision in this next phase of the war lies in our ability to defeat the torpedo in the Atlantic, and win with it in the southern Pacific. The "tin fish" is still making history.

• • •

SUCCESS

Workman's Suggestions Speed Production

How production of vital gunsight lamps has been increased by more than 2000 percent due to a factory worker's suggestions, is one of the many little "success" stories of the nation-wide national defense effort. The tiny lamp, about half the size of a walnut and used in delicate precision mechanisms for aiming big guns, was made entirely by hand only a few months ago; today, with the help of suggestions made by Matthew Westphal, a Westinghouse employee, it is machine made. As many as 2000 can be manufactured in a single day.

Mr. Westphal proposed a different type of stem and redesigned the mount for the filament. Due to his changes in the method of drawing air out of the bulb, it no longer has a pointed tip. Savings in material, labor and equipment have resulted from Mr. Westphal's suggestions. Valuable floor space formerly used by girls sitting at work benches is now available for other work. Girls have been released to do other important jobs. Only half as much glass tubing is needed in the lamp. Old equipment has been discarded and salvaged.

ALL-METAL YACHT

Will Be Used For Patrol Service

It has just been announced that the all-metal yacht "Revere," described on page 79 of the February 1942 issue of Scientific American, has been turned over to the United States Coast Guard for the duration of the war. The power and speed of this unusual water craft should make her particularly useful for waterway patrol service along the Florida coast, the work to which she will be put by the Coast Guard.

ROLLERS

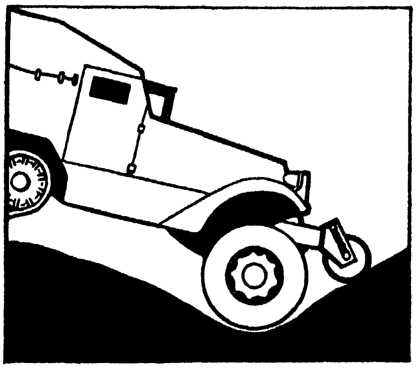
Keep Reconnaissance Cars Out of Trouble

Reconnaissance cars are the advance scouts or feelers of the army and, as such, they must be versatile enough to cover all kinds of terrain American-made units are not only the fastest of any comparable vehicles to be found in the world today, but they are built to travel over extremely rough ground, not excluding trenches and shell holes. One of the features which permits this is the big forward roller--the guiding arm that lifts them out of difficult places.

Mounted in front, like this . .

The all-welded steel rollers on many of the military vehicles now being built by The White Motor Company and others have aroused considerable curiosity and comment among the general public. Many questions have been asked regarding their use, and the projected guesses have been both diversified and humorous.

Actually, the tough tubular rollers, four feet in length and 12 inches in diameter, have a definite and practical use—to keep the vehicles from bogging down and to aid in pulling them out of the difficult spots. In short, these rollers afford the big lift to a machine in trouble. With their help, the Half-Tracs have climbed out of a 6-foot trench during testing operations.



. . It rolls the car up and out

The shell of the big steel roller is made of ¼-inch stock. Two reinforcement rings, as well as two bearing heads, are welded within at spaced positions. The need for great strength in the roller is recognized when one realizes the amount of weight and impact it must bear. Actually, the roller protrudes ahead of the bumper arm and thus takes the first shock when any forward contact is made. Then consider that the cars don't stop for bushes, small trees, fences and similar obstructions, and you can gain some idea of the impacts it must take. Add to this the lifting strength when half the weight of the vehicle may be imposed upon it going up a sharp incline. In order to be most effective, the roller has a spring mounting.

Success of the roller, of course, depends to a large extent on the traction power of the vehicle The conventional scout cars, driving from all four wheels, can push up a 60 percent grade with a full complement of men. The Half-Trac, with its rear track system, exerts even more driving power and is well adapted to soft ground. When this modern reconnaissance unit pushes its front roller against a bank it gains the necessary lift to go on over.

These reconnaissance units are extremely maneuverable and are capable of traveling up to 50 miles an hour on highways or smooth ground. At the same time they can push over the roughest kind of country. The big steel roller in the front goes a long way in making this possible.

Glass Guns for Victory

Soil Testing in Gardens and on Farms Can Aid in Keeping Food Producing Machinery in Order

ARTHUR H. CARHART

In the enormous pattern of national effort, the growing of food crops on farms and in home gardens is of great importance. While our factories, mills, and mines pour out their war goods and raw materials, our good earth must go into full production to deliver a tremendous volume of food stuffs. While gasoline, coal, and electricity power the machines, food powers the men and women who run those machines.

The soil is thus a part of our national machinery for the production of war necessities. Food is as essential in war as guns and powder. The tremendous importance of this part of our war effort is indicated by the fact that, at a National Defense Gardening Conference held at Washington, D. C., last December, there was launched a Victory Garden Program. The national campaign to put the machinery of the soil into capacity production is under way. This is a war of science, and science will aid in garden and farm, just as in laboratory and factory.

The soil of our nation is one piece of defense machinery which may receive a hard and disastrous beating unless we give heed to putting it in top condition and keeping it so. Lowering of the production from our tilled soil may mean the difference between victory and defeat. With the crusade for total utilization of all tillable gardens and farms under full drive, the problem of keeping the soil in top condition and guarding against over-use and neglect must receive continuing attention.

Generally the soil is considered as a medium for growing things, without due recognition of the fact that it is a mechanism as definitely organized in its way as is the machinery within a factory. We plant seed, we water, we hoe weeds—and believe that nature will give us a good crop. Crop failure is often blamed on nature, but the real cause may be pure neglect of the soil machine.

No machine can be forced to produce to full capacity without proper maintenance. Parts wear. Essential cogs in the machine have to be replaced when they are worn. Just as certainly, forced production on tilled land produces wear and tear. Deficiencies occur in soil properties. Since the tilled land is a basic, indispensable part of the war production machinery, we must give it maintenance and replacements when needed, if it is to do its full part in bringing victory.

There are two objectives in such sound soil management as the Victory Garden Program will demand. The first is to bring the tilled ground to its fullest production as rapidly as possible. The second is to have that soil in as good condition at the end of the forced use as it was at the beginning of the drive. With correct management, the soil should not only be as good as it was at the start, but actually better.

Any program aimed at keeping field and garden soils in good condition has two sections. The first concerns the physical makeup. The most fertile soils often are those containing abundant organic matter. This humus is built up in the soil by turning under stubble in a field or spading leaf mold or similar material into the garden plot. Most tillers of the soil know of this need and will take care of it.

But it is the second and less easily determined procedure of keeping soil in first-grade condition that is likely to be overlooked. This involves the chemical constituents present or that must be added to the soil so that it will produce well and so that there will be no loss by excessive use, without replacement, of vital nutrients. This replacement is imperative if the soil is not to be worn out at the end of the forced production war effort.

There are four chemical factors in soil management or production processes that dominate the productivity of any tilled plot. First, there is the question of whether the soil is acid or alkaline. Some crops require one condition, some the other. To attain maximum production, the crop has to be fitted to the soil, or the soil to the crop. If the soil is acid, crops should be planted that will thrive in that condition of soil, or the reaction of the soil should be changed over to alkaline so that crops demanding that condition can be grown. The balancing of the acid-alkaline reaction is not difficult, but it is vital that this factor be known before a crop is planted.

The other three chemical factors involve the principal nutrients needed for maximum crop production. There are a number of plant food requirements in elements in the soil, but the three principal foods are nitrogen, phosphorous, and potash. And because these are the principal soil nutrients required by plants, they are the elements most heavily drawn from the soil in making growth and producing fruits and grains.

Just as milk cannot be drawn indefinitely from a cow without feeding good rations, so the soil cannot be

Soil sample is placed in test tube: testing kit with reagents at right "milked" indefinitely without putting back some of the materials which roots must have in order to produce growth. High-pressure use of soil, where crops are forced for all they are worth, takes a heavy toll of these principal plant foods.

Furthermore, just as a dairy cow must have so much protein, so much carbohydrate, so much roughage, all in a balanced ration, in order to produce the maximum supply of milk, so plants feeding on a soil must have a "balanced ration." In other words, a soil that has adequate nitrogen and potash, but lacks a proper ratio of phosphorous, cannot supply a balanced ration to crops. It all goes back to the machine idea. If one of these elements is left out, an important cog in the crop-growing machine is not in gear

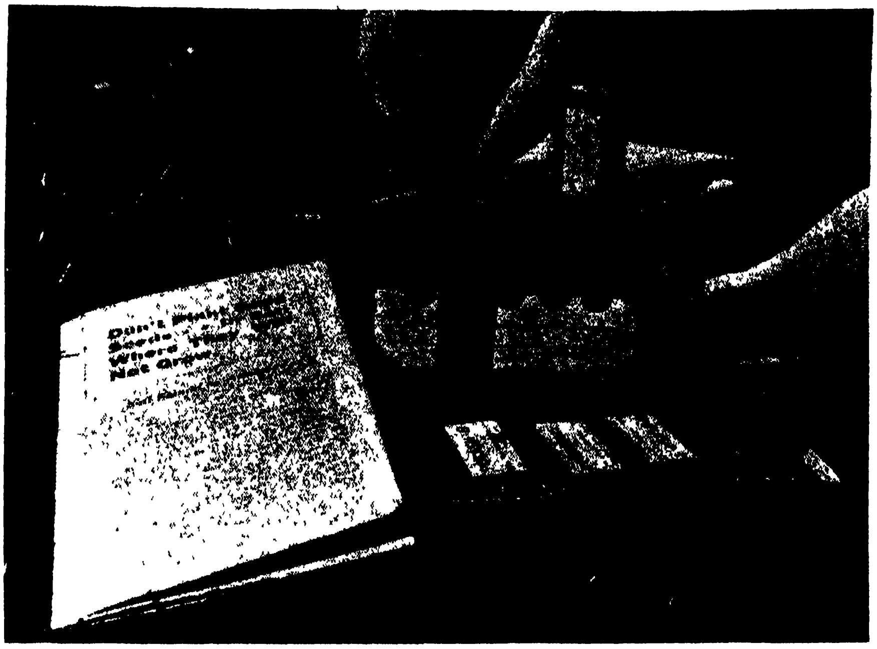
Of course, many farmers and gardeners are familiar with the general idea as it is presented here but it is a little too much to expect the average farmer or gardener to send soil samples every season, or twice a year, if that is better, to some laboratory; wait for the analysis to come back; and then add phosphorous or nitrogen or potash, or, if the soil is sour, to add lime It's a lot of extra work It may not show anything except that the soil is in fairly good shape, and the tendency all too often is to go ahead without analyzing the soil.

FARM and garden journals have been telling about these three most important soil elements for quite some time; state experimental stations have been sending out reports; speakers at short courses have discussed the subject quite fully However, this has all seemed sort of visionary. The dirt farmer, the home gardener, did not have available, until recently, means of analyzing his soil without going to the trouble of sending samples to some distant laboratory.

Today there are soil test kits on the market so simplified that anyone who can read English, and is not color blind, can run his or her own soil test, not in hours, but in minutes and without complicated equipment.

The small soil test kits fit the pocket; others, slightly larger and a bit more accurate, can be carried in containers not unlike lunch boxes and really not much larger. The principal difference lies in the number of tests that can be made with either kit.

Here is how one learns whether the soil is acid or alkaline, what the nitrogen content may be, how much phosphorous is present, or whether or not potassium is lacking. Dig a soil sample out of the field with a common tablespoon, mixing several samples from different parts of the field if a composite test is desired. Put the soil in a glass test tube. (The spoon and test tube MUST be clean) Add the liquid for the desired test, such as for lime, potash, and so on Shake Each of the four tests has its own chemical reagent The reaction of the soil with the solution poured on the soil sample gives a characteristic final color to the liquid


Solution of soil and reagent, in test tube, is checked with color chart

In these kits are four color charts, one for each of the tests Example. A soil sample has been put into a tube. The required reagent has been poured in It has been shaken, and allowed to settle or has been filtered Suppose it is a nitrogen test Select the color chart which is marked nitrogen Hold the tube up, hold the chart, and, by eye, make the nearest match between the tube color and chart color. Opposite the matched color on the chart is a capital letter. It may be "A" or anything on to "D". Having that, turn to the little printed manual that is part of the kit equipment. In that will be found the key letter of each test The letter that designates the color on the chart, matched with the color in the glass tube, gives a direct answer.

That is the net process, for in the little booklet the key letter gives the answer as to how much of each nutrient is present in the soil. It tells how acid or alkaline the soil is in the alkaline-acid test, or how much or how little phosphorous, nitrogen, or potash there is in the soil.

If the soil needs the addition of phosphorous, the manual gives the approximate answer, not in technical terms, but in pounds per acre required to bring up that element to where it should be as a part of the machine to produce crops. It may save adding phosphorous when it is not needed, or upsetting the balance by adding a "complete fertilizer," which is a gunshot way of trying to bring the soil to high productivity, but actually may overbalance one food element already adequately present.

Whatever the primary or associated motives may be that prompt a grower to consider the production potentialities of his fields, every farmer and gardener now has, within reasonable reach, the means for putting the crop-growing machinery of the soil in condition to produce its best The little glass test tubes and the liquids in glass bottles in a soil test kit are genuine weapons in your hands when you start to do your bit toward winning the war with your farm or garden. They are powerful glass guns for those who are getting ready to take their places in the ranks by enlisting in the Victory Garden Program for the duration.

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BREAD PROTECTION

By Addition of Mold-Inhibiting Agent

BY the simple addition to bread of a substance that is naturally present in many other foodstuffs, more than one and a half billion loaves of bread will be protected against mold in 1942, according to the du Pont Company.

Chemists say that the "mold inhibitor" has been proved to have such a marked effect in delaying the growth of fungi in bread, that American bakers striving toward greater food conservation plan to extend its use by 10 to 15 percent during the coming year.

The lowest estimates of losses caused by mold growth on various foods run into millions of dollars annually. Now, with ever-increasing demands on the food supply, the elimination of as much of this loss as is possible becomes a national necessity, even though the rationing of food is not yet a probability.

Mold is believed to be caused by tiny spores of fungi in the air. Usually most active during the summer, these invisible particles develop in bread after baking. Their growth cannot be wholly eliminated even with the best sanitary precautions, air-conditioning, and ultra-violet lamp treatment, but it can be greatly retarded by the addition of the mold-inhibiting agent.

The agent is added to the bread dough before baking; it checks the development of mold particles in the loaf for a period of several days, thus allowing ample time for consumption of the loaf itself. A very small quantity of the mold inhibitor is sufficient for the protection of many loaves of bread, it is said; approximately two ounces of the agent will protect 100 loaves of bread. The agent does not affect either the taste or appearance of the bread.

MICROSCOPE

Identifies Compounds by Polarized Light

A versatile and precise method for identifying organic chemical compounds promises to become a rapid and critical tool of chemical identification for these compounds. The method is one involving the use of polarized light transmitted through a microscope to determine the nature of an organic crystal. The physical principles are not new, but extensive work carried forward during the past decade has resulted in perfecting this system of analysis to the point where it may now be applied with confidence as a positive means of identification for a broad range of compounds.

In du Pont laboratories, a petrographic microscope is being employed that is similar to microscopes used to study the structure of rocks. Following accepted petrographic methods, colored interference patterns are created by passing polarized light through crystals of organic compounds, and these patterns are then compared with known standards to determine the exact compounds being analyzed. Use of light of various colors is an essential feature of the methods.

Although comparatively expensive equipment and considerable experience are essential to an identification of this type, it is said that once these are available, the method can be applied practically to all organic compounds, whether gases or liquids, provided that they can be converted to crystalline derivatives for observation. Only very small amounts of material are required.

The method is reported to be "able to stand on its own feet as a technique of identification, and offers considerable time-saving possibilities in distinguishing between compounds having chemical features in common."

PSYCHIC RESEARCH

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. Further reports of The Scientific American Committee for the Investigation of Psychic Phenomena will be published in forthcoming issues. ●

GLUE . . . OR GLUE

When Is Plastic A Glue?

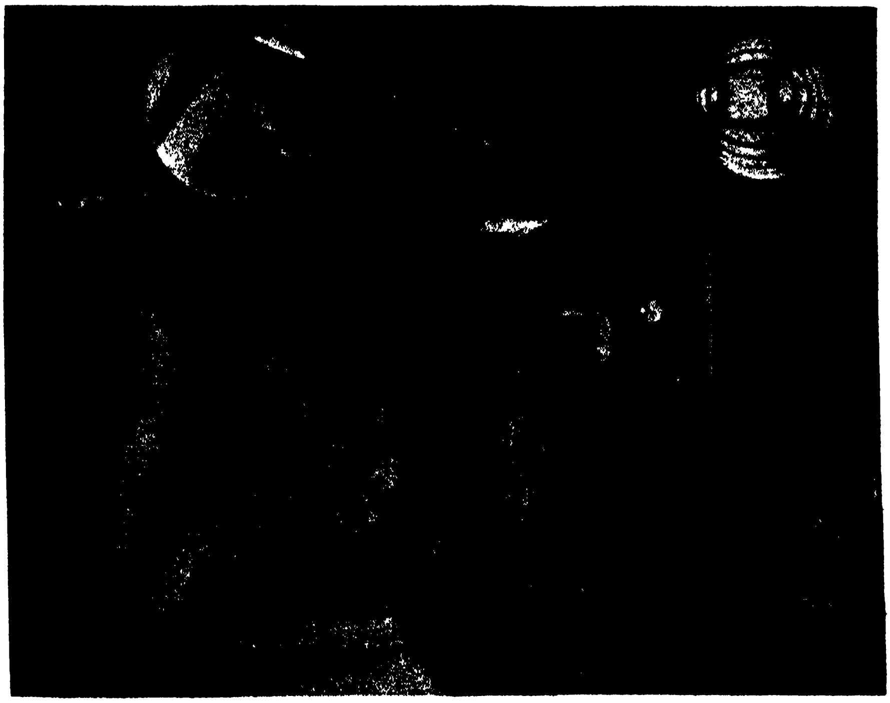
With plywood reaching a position of increased importance in industrial applications, there has arisen a confusion of terms as applied to those materials which are used to fabricate the finished plywood from thin strips of veneer. In this connection a letter recently addressed to the editor by Mr. J. F. Laucks, President of I. F. Laucks, Inc., Manufacturing Chemists, holds considerable interest. The following paragraphs, quoted from Mr. Laucks' letter, clarifies the situation:

"I believe it is time to call a glue pot a glue pot. As a glue manufacturer I am getting tired of hearing glued-up articles being referred to as 'plastics' either because of lack of comprehension of the difference between the plastic art and the glue art or because of some misguided notion that glue is not a subject of polite conversation.

"For some time back now I have been reading articles in the press, in the magazines, in the trade papers and technical journals about *plastic* airplanes, but I submit that these are nothing more or less than glued-up plywood formed into the proper shapes. A plain piece of plywood might just as well be called a plastic.

"Just the other day I saw in one of the nation's prominent newspapers a statement about plywood which ended: 'The old art of using glue has been supplanted.' This was the final straw.

"That there is a great difference between the gluing and plastic processes is commonplace knowledge to anybody who knows very much about either. I personally have good authority on which to base a statement about this difference. I once had to fight a patent suit in which my opponents claimed that there is no distinction between



Petrographic microscope. *Left insert:* Crystal of organic compound. *Right:* Optical picture created in microscope by polarized light through crystal

BENDIX ECLIPSE PIONEER SCINTILLA STROMBERG FRIEZ ZENITH

THE PRODUCTS OF 40,000 BENDIX CRAFTSMEN

safeguard America by land, sea, air!

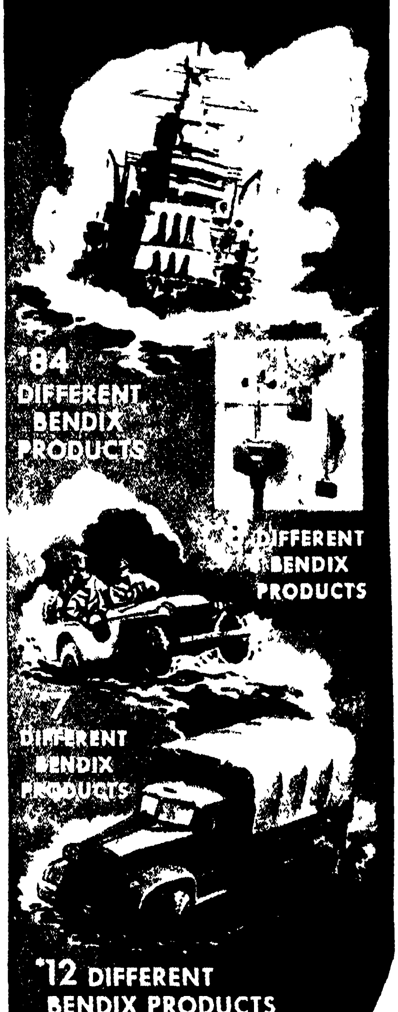
*94 DIFFERENT BENDIX PRODUCTS
*6 DIFFERENT BENDIX PRODUCTS
*15 DIFFERENT BENDIX PRODUCTS

Down scores of production lines that yesterday were only blueprint sketches, roll the implements of the new-born military might of America. Ordnance, bombers and fighter planes, trucks, tractors, tanks and scout-cars, troopships and great naval "battle-wagons," torpedo and picket boats and motor launches —all are vital parts of the impregnable bulwark of steel being forged to safeguard Liberty!

More than two hundred distinct and varied units, designed and perfected in Bendix Laboratories, proved on millions of vehicles and planes and vessels, are produced by forty thousand loyal craftsmen in more than a score of Bendix plants. They stretch from the Atlantic Seaboard to California—and are supplemented by the steady output of many a sub-contracting plant.

The aircraft and automobile industries and our Army and Navy, through whose whole-hearted and close cooperation our own all-out efforts for Victory are so greatly advanced, have just cause for honest pride in a job that is prompt, and prodigious, and properly done!

** Of course, not all of these products are used on any one airplane, vessel or vehicle. However, in certain cases, dual, triple or multiple installations are required These are not considered or included in the figures given above.*


*84 DIFFERENT BENDIX PRODUCTS
DIFFERENT BENDIX PRODUCTS
*7 DIFFERENT BENDIX PRODUCTS
*12 DIFFERENT BENDIX PRODUCTS

Bendix AVIATION CORPORATION

★ ★ ★

Serving the cause of Victory in twenty great plants spread across America from the Atlantic Seaboard to California the plastic art and the glue art. After hearing testimony for two years, the court decided that these are two separate and distinct arts. This decision should carry some weight. If the Patent Office considers these arts dissimilar, and in practice they are entirely different, I think the general public should recognize the fact.

"Perhaps the present prevalent habit of calling everything a plastic that can be remotely included in that category is due as much to the fact that plastics are currently fashionable as from a general disinclination to use the word 'glue ' Plastics, of course, are new. The art of gluing, on the other hand, dates from at least early Egyptian times.

"Gluing might be defined as the art of binding two pieces of wood together to make a joint that is stronger than the wood itself. In this definition I do not state what the binding means are. The ancient glues were made of either bones, hoofs, and hides (whence I suppose the name glue first acquired a bad odor) or of casein. Later came starch glues which do not smell bad, still later came soybean glues which do not smell bad, and later yet came synthetic resins, some of which do and some of which do not smell bad. Now then, just because some glues smell bad, should the entire glue industry be made to feel that it ought to apologize for itself? Should the people who use our product do so on the sly and cover up this fact by declaring they are making plastics?

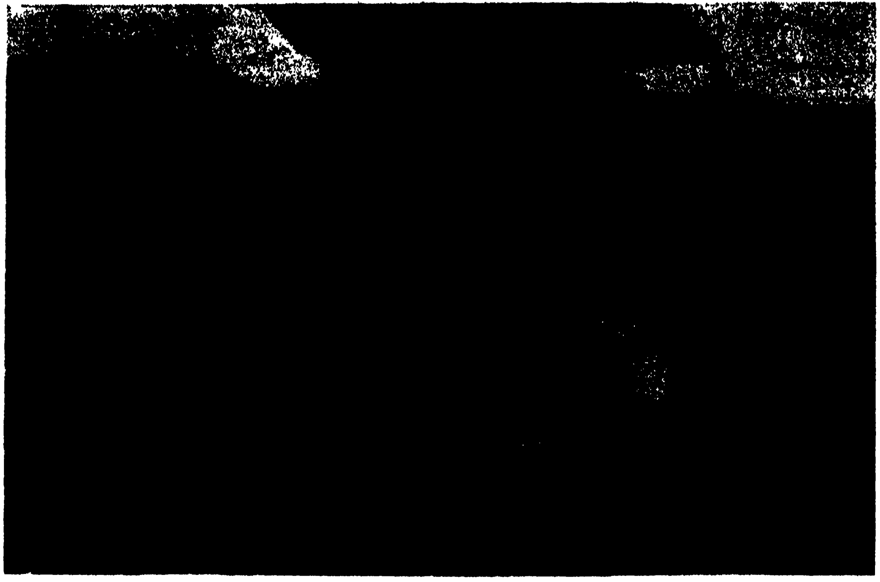
"I maintain that the art of making a joint stronger than the wood is a real art and an honorable one. It is the art of gluing, and neither the man who knows how to do it nor the man who knows how to make a glue to do it with need be ashamed of saying they are in the glue business or that they are using glue. I insist that the old art of using glue has *not* been supplanted but instead is expanding its uses into ever wider fields and is becoming of progressively greater importance every day."

GREEN BLUSH

When Euglena Blushes, Pigments Shift

How *Euglena rubra*, a species of microscopic freshwater animal, reacts to lowered temperatures by changing its color from red to green and taking on the characteristics of a plant, was disclosed in a recent issue of *Physiological Zoology*. Writing on the "Cause of the Green-Red Color Change in *Euglena Rubra*," Drs. L. P. Johnson, of Drake University, and Theodore L. Jahn, of the University of Iowa, revealed that the curious change of color which occurs when the animals are subjected to changing temperatures is due to the migration of red pigments from one part of the body to another.

Specimens of *Euglena rubra* were obtained from a small pond in Iowa, where they formed a bright red scum on the surface of the water. When the temperature of the animals was lowered to below 86 degrees, Fahrenheit, the red pigment near the surface of the cell migrated toward the center of the body, leaving chlorophyll at the surface, which gave the animal a green color The red color was restored by heating, or by subjecting the animals to infra-red rays, artificial light, or sunlight.



Pure water, safe for drinking, from Los Angeles River, by "Sterozone"

PURE WATER

Produced by Portable Ozone Generator

A COMPLETELY automatic, self-contained water purification plant that literally burns bacteria out of water has been developed for use in army camps and by troops on maneuvers, but has industrial and municipal applications as well. The "Sterozone" unit, as the plant has been named, has a rated capacity up to 9000 gallons per hour; automatic parallel operation of units can be made to supply larger requirements.

Raw water is pumped from the source through a filter to remove suspended matter and then passed to an absorber chamber where ozone, generated by a high-frequency silent electric discharge, oxidizes the bacterial contamination and delivers pure, sparkling, fresh water that has no taste or odor. Unlike water that is disinfected by the addition of chlorine, there is no danger of overtreatment which may result in an unpleasant taste that may force troops to prefer untreated, contaminated water.

Power for the plant is supplied from an automatic gasoline-engine driven 10 KVA., 220-volt, 3-phase power plant. This unit is self-starting and self-regulating. The only attention required is lubrication and fueling All mechanism is driven by a five-horsepower, 220-volt, 3-phase electric motor on which is direct mounted the treated water supply pump and coupling. Connected to the other end is the raw water supply pump. Also driven from the motor shaft are the compressor, cooling water circulating pump, and the evaporative cooler.

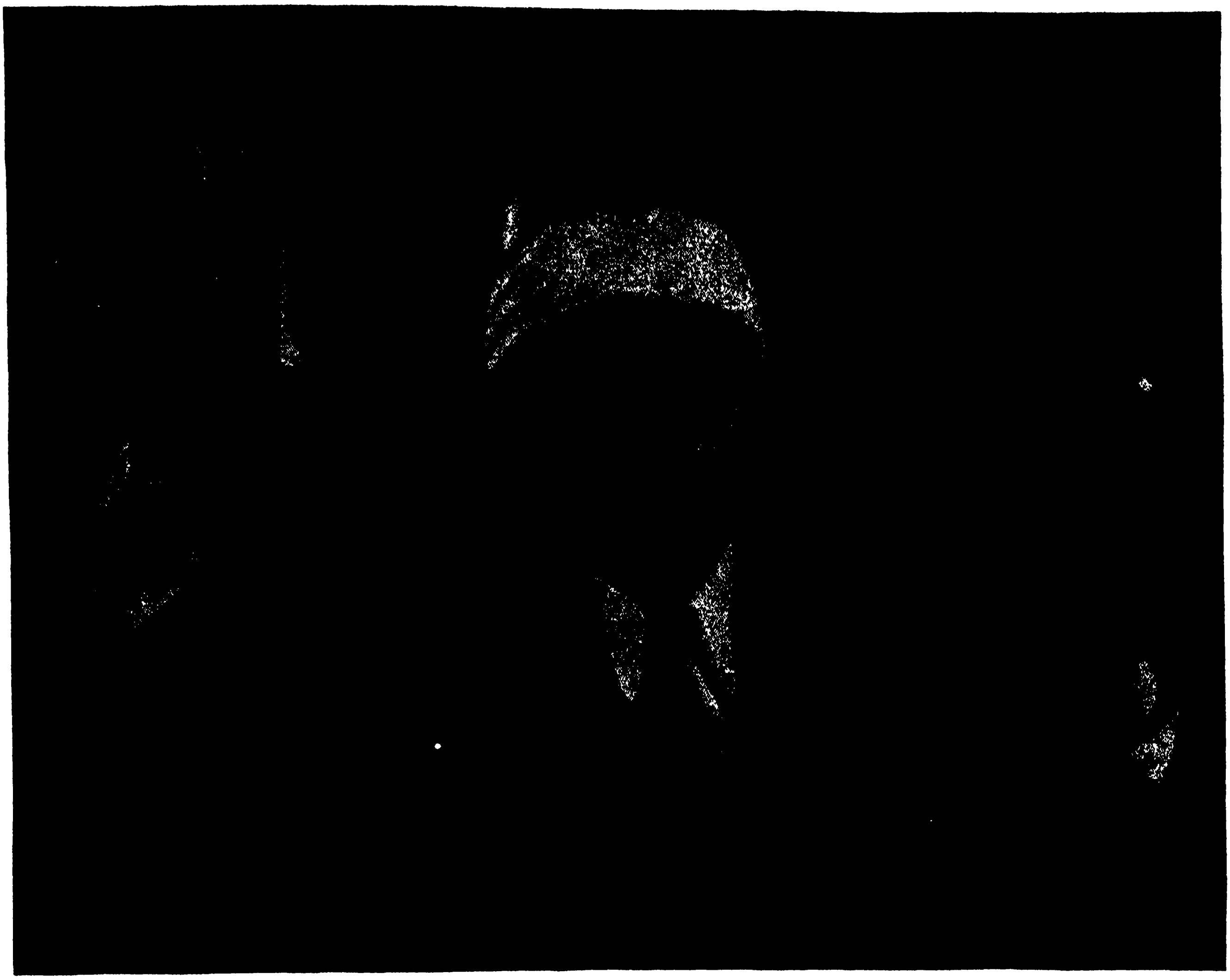
Ozone is generated by the silent blue electric discharge between aluminum plates maintained at 13,000 volts by a 2.0 KVA transformer. Ozonized air is injected directly into the absorber through which it flows counter-current to the water in four separate stages Diffusion, injection, turbulation, and scrubbing obtain efficient absorption of the ozone.

[For a more comprehensive discussion of the principles involved in water sterilization with ozone, the reader is referred to page 136, March 1942 Scientific American.—*The Editor.*]

DRY ROT

Occurs Only When Moisture Is Present

THERE is no real "dry rot" that attacks wood and causes it to decay. Wood must contain more than 20 percent of moisture before fungi can grow in it. What is ordinarily called "dry rot" is caused by one of a few species of



WHITE COLLAR MEN ARE STILL A DIME A DOZEN!

LOOK around your office. A few men have "arrived". They are the executives, earning big money. The others are what the top men in the company call "white-collar workers"—able, conscientious, hard-working—perhaps with specialized training, but they are nevertheless figuratively worth a dime a dozen.

WHAT'S THE DIFFERENCE between the executive and these "white-collar workers"? That's the question being asked by men who have hopes . . . men who want to climb out of the rut and into the top-flight class themselves. The answer is—*there's very little difference!*

Has the man who makes $5,000 twice as much brains as the man who makes only $2,500? Has the man who makes $10,000 twice as much brains as the man who makes $5,000? Of course not! And it would be amazingly easy for *many men* to transform an average salary into a large salary!

HOW IT'S DONE! The difference between success and merely "getting along" lies in executive training. In the old days, successful executives had to gain their ability through long years of experience. But as business became more complicated, educators became business-minded. Many big universities added schools of business; the Alexander Hamilton Institute was founded—and since then has pointed the way to success to more than 400,000 men!

HOW YOU CAN DO IT. The Institute has organized and formulated the knowledge of the country's most successful business men. Cooperating with it are dozens of leaders like Edward R. Stettinius, Alfred P. Sloan and Thomas J. Watson. As a result, the Alexander Hamilton Institute offers you modern, up-to-the-minute training and information you would almost have to give your right arm to gain by any other method!

CUSTOM-MADE TO SUIT YOUR NEEDS. Please get this fact clear in your mind. *The Alexander Hamilton Institute offers a PERSONAL service, geared not only to YOUR particular needs, but to your particular needs TODAY—whether you are a young man just earning his first business laurels, or a busy corporation official who wants to keep up with rapidly changing economic conditions.*

PUT IT UP TO US. Why not prove to yourself that you have the first quality of an executive—the ability to make a decision? Write us for a free copy of that important little book, "Forging Ahead in Business". For many men this simple act has been a major turning-point in life!

I'M TIRED OF STANDING STILL! HERE'S WHERE I START MOVING!

Alexander Hamilton Institute, Inc.

231 Astor Place, New York, N. Y.

Please mail me, without cost, a copy of "Forging Ahead in Business".

Name . . . .

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Position . . . .

fungi that grow rootlike strands that serve as pipelines through which they draw into dry wood the water they must have to live and to destroy the wood. These rootlike strands must reach moist soil or some other source of moisture if the "dry rot" is to cause decay of the wood, say United States Department of Agriculture scientists who have studied the various forms of wood destruction.

Wood kept dry, they emphasize, is a permanent building material. One way to prevent decay of wood is to inject into it preservative chemicals that prevent fungus growth. The other way is to keep it dry so that fungi can not live. Even the "dry rot" fungi can not develop if water can be kept beyond their reach.

SULFA-DOG

The Sulfa Drugs Also Work Wonders in Canine Cures

The big five in chemo-therapy—sulfapyridine, sulfanilamide, sulfathiazole, sulfadiazine, and sulfaguanidine—are proving to be valuable drugs in veterinary practice, according to Dr. Arthur Bryan, Baltimore veterinarian.

In compound fractures, no matter how serious the wound or the possibility of sepsis, sulfoamide powder can be dusted into the wound and healing occurs without infection or even wound fever. Peritonitis may be entirely prevented in small animals by implanting powdered sulfa drugs as a post-operative procedure. In fact, infections of all kinds in our domestic animals appear to be more or less doomed to extinction, if the new sulfa drugs are used in time. Infections of the eye and ear respond promptly to sulfapyridine, sulfadiazine, or sulfathiazole, when these powdered drugs are worked directly into the infected region. Summer diarrhea and dangerous food poisoning infections, particularly of small animals, respond to the recently developed drug, sulfaguanidine, which has a selective action on the intestinal tract.

These sulfoamide drugs, while performing modern veterinary medical miracles, are toxic and dangerous in the hands of the laity, and the up-to-date veterinarian alone is competent to prescribe these drugs for the benefit of our animal population.

FISH

And Their Reaction To Air Raids

Members of angling clubs in various parts of Britain, where heavy air raids have been experienced, report that fish bite much better on the day following a severe blitz in the district. It is believed that the loud noises caused by exploding bombs, gun-fire, and so on have the same effect on fish as thunder. A bad thunder-storm always upsets fish and prevents them from feeding and consequently they are apt to feed voraciously when the disturbance is over.

DECALCOMANIAS

For Chinaware Made by Photographic Process

A new process for making chinaware decalcomanias, which substitutes photo-lithography for hand-lithography in preparing plates from which decalcomanias are printed, makes possible exact and yet rapid reproduction of artists' designs. American independence in chinaware decalcomanias is expected when volume production by this method is attained. Seventy percent of the decalcomanias used by American chinaware manufacturers were imported at the start of the war. An increasing scarcity of decalcomanias helped create unprecedented backlogs in chinaware orders.

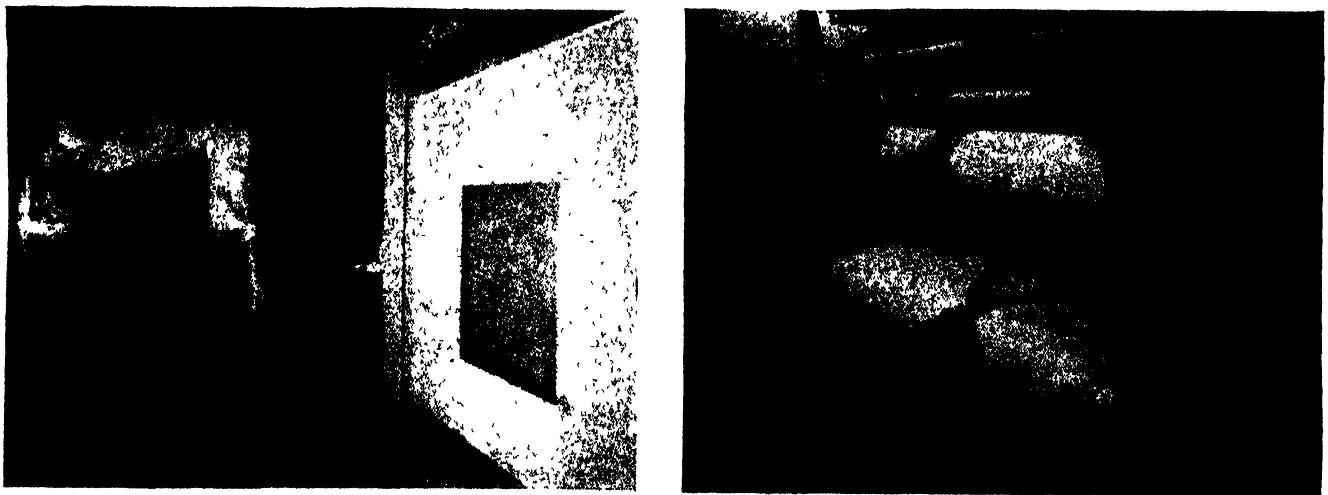
In the new process, artists' designs are photographed through color filters and reproduced on sensitized metal plates, instead of being tediously stippled by skilled craftsmen on soft stone. The designs are then transferred by use of a special offset lithograph press.

It is pointed out that a more beautiful chinaware will be available in all price ranges because photo-lithography can reproduce not only more intricate designs but do so with finer gradations of shading and blending of colors. The color shade of one plate is said to achieve an effect which formerly required three shades of one color, or three different stone plates.

In transferring an artist's design to a stone plate, the craftsman stipples a maze of tiny dots with stippling pens. However, even the most skilled workmen are unable to stipple all the fine dots necessary to copying the design exactly. By contrast, the sensitive photograph plate misses nothing because it actually reproduces the design itself.

The artist's work is photographed through color filters for each color in the sketch. The camera detects and reproduces every detail and vestige of a particular color in the design, though it may not be visible to the naked eye. From each negative a positive is developed, and from that positive is made a sensitized metal plate for the offset lithograph press. The plates, incidentally, may be reused by etching off and regraining.

Petit point decalcomania patterns—which American manufacturers formerly considered very difficult and have been hesitant in supplying—are now being reproduced on dinnerware by photo-lithography. On imported ware, such designs are completed by hand in order to obtain the delicate



Left: Photographing an artist's design for decalcomania use. **Right:** Printing decals on high-speed press effect of many-colored needlework. The new domestic process eliminates the need of this supplementary touching up, as the camera exactly reproduces the intricate pattern and fine shadings of the artist's sketch.

Black and brown etchings of historic shrines and other scenic designs can be copied for the decoration of service plates with no loss of artistic quality. Pictorial designs transferred by the hand-lithograph process appear faded in comparison. Photo-lithography assures not only complete color control for decalcomania patterns but also combinations of line and half-tone which are beyond the scope of the hand method.

Research work on this new process of producing decalcomanias has been conducted by the Ceramic Products Division of the du Pont's R & H. Chemicals Department, long experienced in manufacturing ceramic colors. After many months of work, a satisfactory process was developed and installed on a semi-works scale at a lithograph plant in New Jersey These superior decalcomanias made by the new process found ready acceptance by chinaware manufacturers Demand exceeded supply of decalcomanias from the start, and there is still no indication when equipment will be available to make decalcomanias sufficient to meet demand

SOY BEANS

Uses Have Been Widely Developed by Research

The Jack-and-the Beanstalk growth of the soybean crop and the soybean products industry in the United States has not been a fortunate accident. Instead, "it has been made possible through the results of research" by government agencies and by the industry, according to T. H. Hopper of the United States Department of Agriculture.

Some of the steps in this "phenomenal development," which has added a major crop to American agriculture, and two items already important in commerce—soybean oil and soybean oil meal—are the following: Improved varieties have been selected and bred from foreign seed; utility and climatic adaptations of superior varieties have been improved and farmers have learned to grow the crop; industrial equipment has been developed and greatly improved; the chemistry and physics of soybean oil have been investigated, and methods of refining and improving it for various uses have been studied, and the amount of the meal now used for the manufacture of adhesives and plastics may very materially increase; systematic marketing of soybeans has been instituted, official grade standards have been developed. As a result of this work soybeans have become one of the commodity items of futures trading.

THE NAVY "E" pennant flying over the Bausch & Lomb plant is official recognition of accomplishment in Production for Victory It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make

Courtesy of American Museum of Natural History, New York

When *Gorilla savagei* Visits a City Classroom

To city classrooms Bausch & Lomb Balopticons have brought *Gorilla savagei* and other denizens of the wilds . . . to dust-shrouded schools of Mid-Western plains, the rainbow-hued marvels of the Bermuda Deep . . . to mountain schools, the architectural wonders of spired Manhattan.

Scenes from the far corners of the earth, photographs requiring costly expeditions to acquire, specimens found once in a scientist's lifetime—are now presented for leisurely, detailed classroom study by beginner and expert alike.

All this is made possible because of the Bausch & Lomb Balopticon, a simply operated, economical still projection instrument. So universally is this projector used that the trade name "Balopticon" has become a common noun to be found in the modern dictionary.

To the pupil in the classroom, to the scientist working with precision optical instruments and to the wearers of Bausch & Lomb eyewear, the Bausch & Lomb name stands for optical excellence This name, through the many years of the company's existence has become a part of the pattern of American living

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TELEVISION LIGHT

Supplemented With Fluorescent Tubes

Even with the increased efficiency of television transmitting equipment which has been brought about in recent years, studio designers still are faced with problems of heat generated by the high-intensity light sources required for satisfactory television pick up.

As a new attack on this problem, Westinghouse engineers have recently installed in the Dumont experimental television studios in New York City a lighting system which combines both incandescent and fluorescent lamps. In this installation, 95 percent of the heat felt by the actors is generated by the filament lamps. Performers are normally placed about 10 feet from the lights, which consist of 12 300-watt incandescent spots and 12 40-watt fluorescent tubes. The fluorescent lamps alone supply approximately 300 footcandles, the reflector spots being used to bring local lighting levels up to 1000 footcandles. The 480 watts of fluorescent lighting provide approximately 20,000 lumens of light, the 3600 watts of incandescent about 30,000 lumens If incandescent lights alone were used, another 1500 watts or more would be required to provide the same number of lumens of light on the performers. This, of course, would result in greatly increased heat

Incandescent plus fluorescent

In the experimental set-up shown in one of our photographs, the filament lamps are used only during actual broadcasting. Rehearsals and preliminary work prior to going on the air are done under the fluorescent lamps alone.

FINGER-SIZED

Small Fluorescents Require High Voltages

How fluorescent lamps may be stretched into long ribbons like neon sign tubing, was described recently by Dr. J. W. Marden and George Meister of the Westinghouse Lamp Research Laboratories. In their report presented before the Illuminated Engineering Society it was indicated that finger-sized fluorescent lamps must be a "high-voltage" type as compared with the 10,000,000 low-voltage fluorescent lamps now in use throughout the United States. High-voltage lamps were defined as operating at several hundred or more volts.

The research scientists explained that the biggest fluorescent lamp now manufactured is five feet long, 2⅛ inches in diameter, and consumes 100 watts at line voltages. A 100-watt tube one-half inch in diameter would have to be 24 feet long and would need 2000 volts to supply as much light as the five-foot giant.

In discussing the practicability of high-voltage fluorescent lamps, Dr. Marden and Mr. Meister agreed that they would undoubtedly be used sparingly where high levels of lighting are required, because the amount of light per foot is low in comparison with orthodox lamps In coves, however, and in places where concealed lighting may be wanted and low levels of illumination are satisfactory, they might have considerable utility.

AIR ARCHEOLOGY

War Fails to Stop British Archeologists

In the thick of the Battle of Britain, flying archeologist O. G. S. Crawford, by arrangement with the Air Ministry, undertook an aerial survey of ancient buried ruins of the Roman city of Verulamium near St. Albans.

Prolonged drought had scorched grass growing over part of the Roman city, causing brown streaks to form with unusual plainness on tennis courts and cricket grounds there. These streaks reveal a chess-board plan of the buried Roman city, its streets and buildings. Photographed from 3000 feet, the scorched field has added new features to archeological knowledge of one of ancient Britain's outstanding cities.

A widening of the ancient east-west road of the city formed what may have been a parking area of the 2nd Century A.D., Philip Corder, curator of the Verulamium Museum, reports in the British Journal, *Archeology*, from study of the air views, according to *Science Service*. The plan of a small Romano-Celtic temple and evidence of many other buildings are disclosed.

GLACIERS

Of Comparatively Recent Origin

Glaciers in the Sierra Nevada mountains are recent in origin and are not relics of the Great Ice Age as tourists are frequently told by guides, according to Dr. Francois E. Matthes, of the United States Geological Survey.

"The small glaciers of the Sierra Nevada are commonly believed to be shrunken remnants of the large glaciers of the Great Ice Age," Dr. Matthes says. "However, facts indicate that these glaciers have been in existence but a short time and are successors to, rather than remnants of, the Ice Age glaciers. They probably originated at about the same time as Owens Lake, which is fed by the snows of the Sierra Nevada. From its salt content, the age of the lake can be estimated as less than four thousand years.

"The lake and glaciers therefore may have been created with the advent of the present relatively cool and moist conditions which followed the Ice Age. It is probable that they made their last advances in the 17th, 18th, and 19th Centuries, and that the glacial deposits in the region date from the last great advance in about 1850."

Evidence of the youth of the Sierra Nevada glaciers is seen in the relatively small bulk of the material deposited by them, Dr Matthes declares. This material could not represent an accumulation of ten thousand years, the time that has elapsed since the Ice Age.

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STERILIZER—Equipment used for canning salmon at Ketchikan, Alaska, is being used for packaging first aid kits. The kits are delivered by the machine sealed and sterilized.

• • •

DEODORIZER

Of New Design, For Home, Office

Four cannisters filled with activated carbon, a dust filter, and a circulating fan operated by a 40-watt motor are the essential parts of a newly designed odor adsorber recently announced by W. B. Conner Engineering Corporation. This unit, enclosed in a metal cabinet, is intended for use in homes, offices, hospital rooms, and so on where the air is sometimes contaminated by odors or certain gases.

Carbon does the trick

In operation, the contaminated air is drawn into the Dorex Odor Adsorber, as the unit is called, by means of a fan. It is then drawn through the dust filter and then through the activated coconut-shell carbon before being returned to the room. The carbon adsorbs the odors or gas in the air so that all the impurities remain in the unit and only clean, odor-free air is discharged. The carbon can be reactivated, upon saturation, and used over and over again The air handling capacity of the unit illustrated in these columns is approximately 100 cubic feet per minute

SKULL CUPS

Odd Drinking Vessels Used in America

Some of the earliest Americans made drinking cups of human skulls, according to Dr. Ales Hrdlicka, Curator of Physical Anthropology of the Smithsonian Institution, who found new examples of this macaber practice in village sites on Kodiak Island

The Kodiak Islanders whose remains were studied were among the first migrants from Siberia to settle on the North American continent They were cannibals, so there was no shortage of skulls from which to make the cups

The practice, it is believed, was not solely utilitarian. The Pre-Koniags, as Dr Hrdlicka calls the long-vanished people, may have used skulls of valorous enemies for cups in the belief that some of the virtues of the former owner would be transmitted to the beverage.

At one time, Dr Hrdlicka says, the practice was widely distributed over the world and dates back at least to the late Stone Age in Europe In America it can be traced over both continents The Araucanians of Chile honored some of the slain leaders of Spanish expeditions against them by converting their skulls into bowls.

EARLY SMOKING

Use of Pipes Dated to 5th Century

The American Indians introduced the use of tobacco to early European explorers, but who introduced it to the Indians? This question is probably unanswerable, but evidence of the earliest known smoking of pipes, dated at some 1500 years ago, has been found by the Field Museum Archeological Expedition to the Southwest. The fuel may have been tobacco, or may have been oak leaves, grasses, or something else.

This is one of the discoveries reported by Dr Paul S Martin, chief curator of anthropology at Field Museum of Natural History, and leader of the expedition, upon his return from a prehistoric site which he and associate archeologists have been excavating in New Mexico

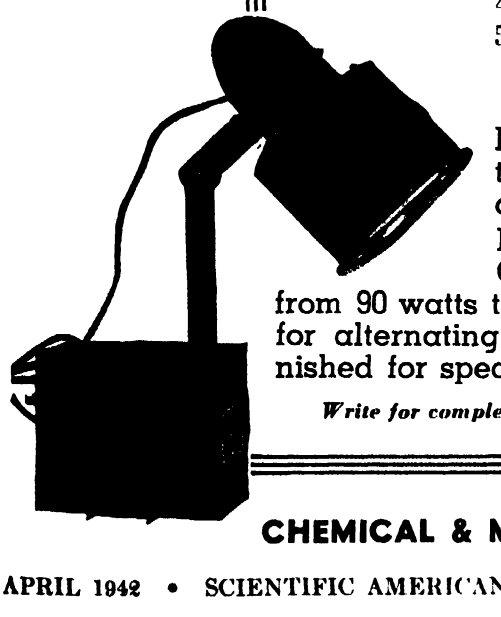
The ancient village which the expedition brought to light, in the ruins of which a number of pipes were found, is estimated to have flourished about the 5th Century A D, or approximately a thousand years before the first white man invaded America and learned about smoking. Members of all tribes of Indians in the area from the Great Lakes to Argentina have had the smoking habit for centuries, says Dr Martin, but the people who inhabited the village he has unearthed may have been the very first to indulge.

MOTOR MOLES

Cars Operate Under Ideal Conditions

Down under Detroit, two topless roadsters without license plates roll over 22 miles of roadways many times daily. They travel in weather always dry and clear, climb no hills, halt for no traffic lights

These roadsters are the foreman's car and the service car for a rambling,



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160-acre salt mine 1100 feet under Detroit. The city traffic rumbles on above, neither affecting nor affected by the mine beneath it. The mine also has many miles of narrow-gage railroad and electric locomotives moving trains of cars loaded with lumps of blasted-out salt to the crushers, graders, and sorters. It also has an office and even a machine shop to keep the machinery in order. Getting the roadsters into the mine was a problem. They wouldn't fit into the elevator with the tops on. Since there was neither rain nor sun, nor snow, nor hail in the mine, the tops were removed and the cars were lowered into the shaft.

TARTARIC ACID

From Corn Becomes A Possibility

With imports of tartaric acid cut sharply by war, and with its price increased nearly 150 percent, the United States Department of Agriculture is watching the results of research that indicate the possibility of converting corn into tartaric acid

Dr O. E May, Director of the Northern Regional Research Laboratory at Peoria, Illinois, has reported that research workers of the Laboratory have developed an efficient and cheap means of producing from corn sugar an intermediate product, 5-ketogluconic acid, from which tartaric acid may be synthesized. The method worked out on a laboratory scale will be tested in pilot plant equipment The United States has a plentiful supply of corn sugar or glucose.

• • •

PORCELAIN — Defense-needed plastics, aluminum, and hard rubber are being replaced in many cases by a new type of porcelain developed by Westinghouse.

• • •

CORROSION

Resisted By Powder For Damaged Tin Surfaces

When tin surfaces have been damaged by handling, or worn away through use, or burned away in welding, the defective area can be repaired with a new metallic coating powder made by American Solder & Flux. The repair material, however, is not intended for use in containers that come in direct contact with food.

In use, the metallic powder is placed on the area to be repaired and heat is applied. Since the powder has a lower melting point than tin, the heat used for melting it does not disturb the original surface. It is stated that a surface repaired with this powder is rust and corrosion resistant and resembles a tinned surface in appearance.

MATCH SOLDERING

Made Possible With New Units

Strong, perfectly soldered electrical connections can be obtained without the use of the conventional soldering iron or torch, through the medium of "Jiggers." Each Jigger is a small self-contained soldering unit consisting of the correct amount of 50-50 solder and flux hermetically sealed within a waterproof heat-generating outer shell.

The sequence of operations in using these soldering units is shown in one of our illustrations. The wire splice is pushed into a Jigger and a lighted match is applied to the outer shell The shell ignites and produces the correct temperature to flow the solder into the splice The burned shell is then dropped off, leaving a clean soldered splice.

Slip it on twisted wires, ignite with match: Soldered joint results

PEAT

Brown Gold Of Alaska Muskegs

Alaska has a virtually untouched "Klondike" in its 110 million acres of peat muskegs—if anyone can develop satisfactory and inexpensive ways of packing and transporting the peat Farmers and gardeners use commercial peat to supply soil humus. They also use peat for bedding in stables and as poultry litter that, in turn, becomes valuable manure. Several kinds of peat make good composts when combined with waste materials Alaska fertilizer supplies also include fish-canning wastes.

The United States Department of Agriculture recently concluded a preliminary survey of the peat resources of Alaska, with a view to possible encouragement of a small-scale peat industry. Many muskegs are accessible from the coast.

The survey revealed sphagnum moss peats and sedge peats, both desirable for improving soils and for other agricultural uses. Through ages, this peat has accumulated on the surface and now forms layers from four to six or more feet deep. Only simple tools are needed to dig the peat. The surveyors made no exact estimates of supplies, but the reserves are ample.

Chief obstacles to marketing Alaskan peat are the short summer season, sparse labor supply, and transportation problems. Local plants could dry, shred, and pack the peat, but economic studies will be needed before the Department can recommend development of an Alaskan peat industry.

POWER ALCOHOL

Not Yet Feasible or Necessary in United States

Periodically there crops up a discussion regarding the use of alcohol as a motor fuel in the United States Sometimes this discussion is motivated by a desire to conserve fuel obtained from petroleum and sometimes by a desire to create more extensive outlets for agricultural products It is known, of course, that power alcohol is being widely used abroad and hence would seem to be a logical development in this country

Because of the uncertainty of the exact status of power alcohol, from the standpoint of both technology and economy, it is interesting to note a part of a letter recently addressed by President Roosevelt to Honorable Gordon H Garland, Speaker of the Assembly, California Legislator This letter was in answer to a communication from The Honorable Mr Garland regarding a joint resolution urging the establishment of plants for the conversion of surplus fruit and vegetables into alcohol for use in national defense as an auxiliary fuel

"While it is true," stated the President, "that a number of foreign countries process agricultural materials for the production of alcohol as a motor fuel, it is equally true that the motor fuel economy of countries possessing no petroleum resources is very different from such economy in the United States. It has never been established in this country that the conversion of agricultural products into motor fuel is economically feasible or necessary for national defense.

"On the other hand, it has been recognized for some time that a real need exists in this country for the development of all the information possible on this very contentious subject. Hence a pilot-plant is being set up at the Northern Regional Research Laboratory of the Department of Agriculture at Peoria, Illinois, to make such studies. Until this plant is completed and has been in operation on a variety of agricultural products for such time as may be required for the collection of essential data, it would not seem advisable to undertake the project advanced in Assembly Joint Resolution Number 21."

FIRE-SAFE

Air-Conditioning System Fire Yields Lessons

FIRE-SAFE air-conditioning equipment is of primary importance to public buildings and stores where large numbers of people congregate. For this reason a fire which originated in the air-conditioning system of a Toledo, Ohio, department store has been carefully studied with a view to determining measures to safeguard against similar occurrences in the future.

The Toledo fire occurred in a four-story and basement structure, starting in the room housing the air-conditioning equipment. First indication of fire was smoke issuing from a louvre in the wall of this room. Then haze poured out of the air-conditioning ducts. The manual controls for the louvre openings and the control switch for the air-conditioning system were located in the air-conditioning room. Fortunately, an engineer was able to work his way into the room housing the equipment and pull the control switch just before the sprinkler heads operated and extinguished the fire

The only direct fire damage was to the interior of the air-conditioning room and its equipment. Damage by smoke to merchandise was remarkably small, apparently because some of the particles were removed from the smoke by the fiber-glass filters of the air-conditioning system. These filters, coated with a non-flammable dust-holding oil, also acted as a fire barrier to prevent spread of fire through the ducts.

It is apparent that the fire actually started in an accumulation of flammable material which may have been drawn into the air-conditioning room through the return louvres located at floor level. Since the fire these louvres have been relocated seven feet above the floor. Also, the louvre and motor controls have been removed to the outside of the air-conditioning room where they can be more easily reached.

This fire clearly shows that the important factors to be considered in installing air-conditioning equipment are as follows: Automatic dampers should be provided on both sides of filter chambers; fine screening should be placed in all return ducts or louvre openings to

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No 9	"	1¼"	1 "	16.50	35.00

← GEAR

No 1⅛	Gear	⅛"	Price $ 9 00	With A.C motor	$25.00
No 2	"	¼"	" 10.00	" " "	27.50
No 3	"	⅜"	" 11 50	" " "	28.50
No. 4	"	½"	" 12 50	" " "	32.00
No 7	"	¾"	" 15.00	" " "	37.50
No 9	"	1 "	" 16.50	" " "	49.50
No 11	"	1¼"	" 48.50	" " "	on request

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1 Amp	$1.10	20 Amp.	$3 15
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Sh Wt 8½ lb $5 00
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600 Watt	$7 50	1200 Watt	$10.50
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TYPE	H.P.	R P M	CU FT MIN	INLET	OUTLET	PRICE
0	1/20	1750	160	4½"	3¾"	$22 00
0½	⅛	1750	350	6½"	3¾"	25 00
1	1/6	1750	535	6 "	4½"	30 00
1¼	¼	1750	950	7½"	6 "	37 50
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prevent flammable material from entering; air filters should be of a type that will not burn; horizontal ducts should have a number of door openings for ease of cleaning; remote control at an easily accessible point should be provided for louvres and motors; all portions of the room housing the air-conditioning apparatus should be equipped with sprinklers.

BLACKOUT BULB

Yields Blue Light, Directed Downward

DESIGNED for blackout lighting in air raids, a new blackout bulb provides downlighting in a soft beam of blue light that is safe for indoor visibility during blackouts. The bulb, just announced by the Wabash Appliance Corporation, is lined inside with a silver reflector lining that hides all filament glare and projects the light downward. Light leaks are prevented by a black silicate coating that covers the bulb up to the extreme lighting end, which is a deep blue.

Blue light for blackouts

FLAMEPROOFING

Made Possible By Laboratory Curiosity

EVERY minute and a half—on the average—a home catches fire somewhere in the United States. Blazes often start from fireplace sparks. Sometimes a flimsy window curtain blows over a gas range burner. Smoking in bed is a common dangerous practice. And children still play with matches.

From now on, such fires need never happen. Thanks to chemical research, all the flammable fabrics in the home may be "flameproofed" simply and effectively. With many of them, it's as easy as starching on wash day.

MISCELLANY

Annually, some 8700 fatalities from burns are listed, along with countless injuries. Many of these are attributable to clothing that caught fire.

A great decrease in such accidents is foreseeable by "flameproofing" our clothing. The sheerest negligee, a velvet evening gown, the arc-welder's overalls, the little girl's frilly party frock, all may be treated by dipping or spraying with the chemical so that, though they may char upon contact with flame, they will not flame or support combustion.

Fabrics immersed in a solution of one pound of the new fire retardant, ammonium sulfamate, to one gallon of water, and then dried, will remain incapable of supporting fire until washed, when the treatment is repeated Drycleaning does not remove the fire protection quality or appreciably impair it.

Moreover, this chemical newcomer, first announced on page 140, March 1942 Scientific American, is said to be unique because it does not affect the "feel" or appearance of fabrics. Indeed, it takes an expert—or a flame—to distinguish between treated and untreated goods.

Until three years ago, sulfamic acid, the crystalline powder from which the ammonia salt for flameproofing is made, was a laboratory curiosity. All known methods of producing it were prohibitively costly, and had always been since the acid was first tediously prepared by the Swedish chemist Berglund 63 years ago

Then, in 1939, at the Experimental Station of the Du Pont Company, an economical way of making sulfamic acid was developed. At that time scarcely a single practical use was known for the acid.

But a few weeks ago a plant to manufacture the new industrial chemical by the tons was opened It is the first and only plant of its kind in the world The reason for it being built is that sulfamic acid and its derivatives are now known to be useful for more than a dozen important purposes, ranging from leather tanning and dyeing processes to killing poison ivy and ragweed—and now flameproofing textiles.

Because it affords such a high degree of protection against flame and flying sparks, the fire retardant has for some months been used in airplane manufacture, in workmen's clothing in steel mills and in shipyards. A disastrous fire in the chemical laboratory of a large university recently led to the flameproofing of students' "lab" smocks.

Of particular importance, safety engineers point out, is the flameproofing of pile fabrics. These are prone to "flash" burn—that is, flame will liter-

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Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator Single cylinder, 4 cycle air cooled 2⅛ inch bore, 5 inch stroke, 1400 RPM, battery start ignition. Weight 340 lbs.

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B-2(J-3)	Amp Hrs 37	Ea 5 50
M 8	Amp Hrs 11	Ea 2 00
L 20	Amp Hrs 13	Ea 2 50
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All cells 1 2 volts each

Above prices are per unit cell For 6 volt system use 5 cells 12 vt —10 cells, 110 vt 88 cells Note On all cells 75 amps or less an additional charge of 10% is to be added for trays

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Makes written record of code on paper tape Ideal machine for learning code or teaching code to groups Radio men can easily adapt it to short-wave receivers for taking permanent records of code messages. Double pen permits simultaneous recording of two messages Pens operated by battery and key while tape feeder is spring driven Made of solid brass on heavy iron base Useful on fire, burglar alarm and watchman systems May be used to intercept telephone dial calls 10 ohms Rebuilt & finished.

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Most garden failures result from a badly balanced diet of plant foods—or an acidity condition which may be actually poisonous to the plants you want to grow.

For example, potatoes develop scab in soil that is sweet enough to grow asparagus. You cannot grow good carrots, beets, and other root crops unless there is plenty of *potash* in the soil. But more *nitrogen* is required for grasses and for tender lettuce, spinach and other leafy vegetables. Flowers blossom to perfection only when amply fed with *phosphorus*.

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ally sweep across the nap in an instant.

Broad usage of the fire retardant is fairly certain to open up in two other fields where safety is an urgent need. One is in paper, especially for decorative purposes. The other adaptation lies in treatment of insulating materials to prevent the spread of flames in frame dwellings.

Some progressive dry-cleaners and laundrymen already are offering customers a fire retardant treatment for clothing, bed-sheets, blankets and the like. It is predicted that textile mills will shortly begin flameproofing fabrics in course of manufacture.

FOREST FIRES

Greatly Reduced in Protected Areas

THE forest lands of the United States are now better defended against fire than ever before, according to the United States Department of Agriculture. Vast strides have been made in the increase of forest area being given fire protection and in the fire control methods and equipment being used.

In addition, the Forest Service points out, fire lookout towers and both federal and state lookout stations are available, if needed, in the present war for use as air-raid spotting stations and detection of possible enemy signal fires or incendiary sabotage. These mountain stations, once vulnerable to telephone-line service troubles, are now made much less so through the adoption of shortwave radios by the Forest Service.

Like modern armies, up-to-date fire control organizations have been mechanized. Portable power water pumps have replaced the 10-quart pail and, whenever practicable, handtool fire line construction is supplemented with the use of portable power-driven equipment. Airplane transportation of supplies, equipment, and manpower to inaccessible fires where delivery is made by parachute, now regular procedure, is a practice unknown during the last war.

A little more than 11 million dollars in funds will be available for this forest fire protection during the 1942 fire season. The Department's foresters estimate that an additional six million dollars would be required to protect all forest lands needing it. A total of 146,000,000 acres of forest land in the United States still lack any organized fire protection, according to the Forest Service. The unprotected area amounts to about one-quarter of all the country's forest lands needing protection.

Fires on unprotected forest lands accounted for 87 percent of all the area burned over in the United States last year.

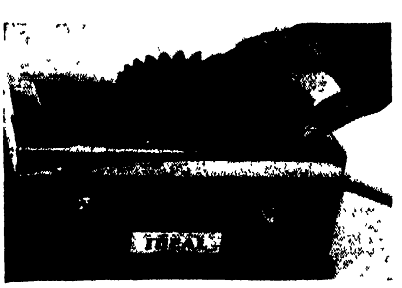
Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

DEMAGNETIZER

For Equipment Used In Production

When tools, drills, punches, and other machine shop equipment and work pieces become magnetized, as they do when being used with magnetic chucks, they are bound to attract small and sometimes almost invisible chips and dust. These particles, clinging to the magnetized cutting edge of a tool, act as an abrasive between the tool and the work, causing the tool to bind or heat and dull quickly.



Prevents metal pick-up

Such magnetized machine shop equipment can be quickly demagnetized with a powerful, portable demagnetizer recently announced by the Ideal Commutator Dresser Company The tool or work is merely passed across the magnetic poles of the unit or, in the case of large parts, the magnetizer is moved over the work. Tools that have been demagnetized will stay sharp longer, will cut faster, and are more accurate than magnetized units.

INDUCTION HARDENING

Saves Much-Needed Copper for Defense Use

Before induction hardening was adopted by a large automobile plant, it was necessary to use copper bushings in the rocker arms to prevent them from wearing out the shaft. Increasing the shaft hardness from 20 to 50 Rockwell C by high-frequency heating and quenching has resulted in a hardness sufficient to prevent shaft wear when the rocker arm is used without the copper bushing. Nearly five million shafts have been processed during the past two years without a single reject that could be traced to improper heating. Since about 14,000,000 bushings weighing four-fifths of an ounce each were needed annually, a savings of 35 tons of copper resulted

In the manufacture of rocker arm shafts, the steel is cut in 12½-inch lengths out of ¾-inch bar stock, and ground. Shafts are then bored, counterbored, and faced for length simultaneously in one machine at the rate of 185 per hour, using 26 machines to maintain the present schedule of 12,000 units daily. The shafts are then hardened inductively by a "two shot" process, necessary because localized hardening at six different points around each oil hole in the shaft is desired. Units are dropped into holes where they are held in position by a cam supporting the end. High-frequency current from a Westinghouse 240-kva, 3000-cycle generator is applied at three sections which are heated to about 1500 degrees, Fahrenheit, and quenched. The cam then releases the shaft causing it to drop two inches, and the process is repeated Hardening of the entire shaft is not desirable as it would become brittle and susceptible to breakage.

Shafts are hardened six at a time in an upright hardening furnace in which the heating and quenching cycle is 4½ seconds. No oxidation of the surface results, and there is no grain growth of the unhardened metal sections. Although there is some distortion of the hardened shaft, further machining except for finish grinding and lapping is unnecessary.

STRAIN GAGE

Prevents Breakdown of Industrial Machinery

In some types of machines, such as punch presses, shears, and press brakes, the strain during a cycle of operation occurs for a very short period of time —rising abruptly to the maximum and then falling sharply to zero. It is this kind of machine for which a new electro-magnetic gage has been developed

It is now more serious to have a machine out of commission than ever before. The loss in production is doubly great because a longer-than-normal idle period is probable. Men, materials, and

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machines that are sorely needed in building new machines must be diverted from their production roles to replace a broken part.

The gage need not be applied directly to the vital part of the machine under strain but it can be applied to any part of the machine whose stress represents the equivalent stress on the vital part. The gage, comprising a rod, lever arm, and head, looks like a side view of an automobile jack. The handle is the gage rod, the jack is the lever arm, and the base is the gage head.

The rod is fastened at either end to the machine in the direction of the strain. The lever arm, attached at its outer end to the machine, is at right angles to the rod. The gage head is mounted on a plate that also is attached to the machine at a point on a line with the lever arm. The gage head consists of an armature operating within two coils.

Before the job is started, the position of the armature within the coils is adjusted so that a zero reading is registered on a connected instrument. When the machine is put into operation and strain exerted, the rod pulls down on the lever arm. The arm in turn pulls down on a pin in the armature and moves the armature to a new position within the coils. This affects the electromagnetic relationship between the armature and coils in accordance with the amount of strain exerted. The instrument, previously calibrated against known strain loads, then indicates to the machine operator the extent of the unknown strain.

RELAY

Uses Current Only When Operating

Positive operation and low current consumption are features of a new start-stop relay which has been recently designed for remote-control starting and stopping of radio transmitters, drainage pumps, and other appliances. This new relay, announced by Automatic Electric Company, operates and releases over two wires, with a common return. A typical method of operation is by the use of a two-way key, which is thrown into one position to close the relay and into the other position to release the contacts. The operating circuit of the relay opens immediately after the contacts open or close; thus operating current is consumed for only about 1/10th of a second.

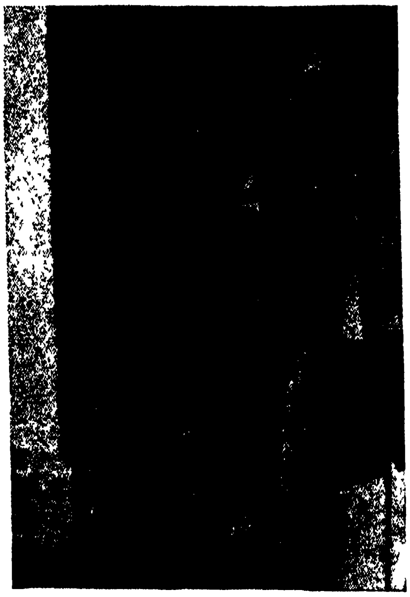
Economical of operating current

This new relay, available with any number of contacts up to 18, has been tested under operating conditions over a temperature range of from −22 to +131 degrees, Fahrenheit.

CART

For Easy Transportation Of Welding Tanks

Handling of welding tanks is facilitated by the use of a new narrow-width cart recently designed by Garlinghouse Brothers. This cart, shown in one of our illustrations, has a total width of only 24 inches yet carries the two tanks required for oxy-acetylene welding. These tanks, instead of being placed side by side, are set one behind the other, making possible the narrow width which is so desirable for use in crowded shops or narrow aisles.


Through a narrow door

Either tank may be moved independently of the other, as the acetylene cylinder is inserted at the front while the oxygen tank rests on its own platform in the rear of the cart. A tool box and two rod holders, for long and short rods, are attached to each cart in convenient positions.

The chassis is mounted on large pneumatic tired wheels so that the cart may be wheeled over rough, uneven ground or littered floors.

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Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim School of Aeronautics, New York University

CONGRESSIONAL reports would have it that our pursuits are not equal to the pursuits of other nations and that our P-40 is well behind the times and only suitable for advanced training. The Congressmen who voiced this opinion did not know that the P-40 was followed by the P-40 A, B, C, and so on, which may be reckoned among the world's fastest and most effective fighters. Perhaps, also, the Congressmen in question had never heard of Republic Aviation's Thunderbolt, known technically as Republic XP-47B. This remarkable interceptor plane is perhaps the very first single seater to be powered with a 2000 horsepower engine. While specifications remain secret, there is reason to believe that the Thunderbolt is the most effective interceptor produced anywhere in the world. Tests of the ship, which is shown in our photograph, were remarkably successful. The Thunderbolt is an interceptor which has the strong fire power needed to attack enemy bombers and fighters. Readers will note that to absorb the enormous amount of power developed, a four-bladed airscrew of large diameter has to be employed. On the under side of the wing a hole is shown, uncovered. Into this the landing gear retracts, with the surface automatically smooth after retraction. The picture shows a very wide tread of the landing gear in relation to the span of the wing Any pilot who has to come down at the speed of a heavily loaded airplane of this type will understand fully why.

It is an open secret that the Thunderbolt will be built in large numbers and it is certain to give a good account of itself. Another remarkable thing about this new ship is that it was in the air exactly eight months after the order to begin work had been received from the Army Air Corps, an indication of sound knowledge on the part of the engineers.

PLYWOOD

Utilized as Float, Conserves Aluminum

IN these days, when every pound of aluminum is precious, it is only logical that resort should be had to plywood, particularly in the aircraft industry for civil use. It is not surprising, therefore, that the Heath Company has produced a laminated plywood float with plastic bonding or glueing. In earlier days, when glue was of animal or vegetable origin, it was never quite bacteria-proof and never quite waterproof. Floats built then had the unfortunate habit of peeling off.

In the floats shown in our photograph, Honduras mahogany veneer is used for the skin, fastened together with perfectly waterproof and resistant cold resin glue. Another advantage of

When 2000-horsepowered Thunderbolts are hurled at the enemy . . .

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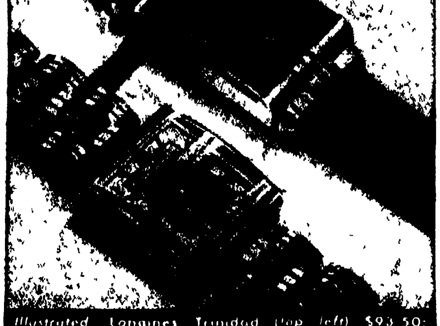
Charm is expected in a Longines ladies' watch. Unexpected is the unusual accuracy and sturdy dependability of this tiny mechanism. Ten world's fair grand prizes and 28 gold medals are Longines' awards for elegance and excellence. Longines-Wittnauer jewelers show Longines Watches for every timekeeping need; also Wittnauer Watches, a companion line moderately priced from $29.75—product of Longines-Wittnauer Watch Company, Inc., New York, Montreal, Geneva.

Prices include Federal Tax


Longines Watches have won 10 world's fair grand prizes, 28 gold medals

Illustrated Longines Trinidad (top left) $93.50; World's Fair 1A (top right) $67.50, World's Fair strap [illegible] $67.50; Hall of Fame man's bracelet [illegible]

the use of plywood in floats is that the top skin of the float is one piece of plywood 15 feet long, bonded to the float structure in a large hydraulic jig that applies pressure evenly to the whole surface. The float is left in this jig for four hours. No nails are used so that the outside surface is perfectly smooth.

Another innovation lies in the transparent inspection covers which enable the operator to check with a flashlight for water in the floats. Water rudders are placed at the end of the floats and actuated in conjunction with the ordinary rudder located at the tail end of the fuselage.

For inexpensive conversion

These floats, which weigh only 69 pounds apiece, have been approved for seaplanes not exceeding 1,560 pounds in weight. It is an attractive idea to have a low-powered airplane which can be used either as a land plane or, with these cheap and efficient floats, as a seaplane. Perhaps the only criticism we might make is that the landing gear may have too many exposed resistance parts in struts and bracing wires.—*A. K.*

CIVIL AIR PATROL

Offers Possibilities of Varied Services

THE Office of Civilian Defense has had the good fortune to secure as Aviation Aide to the Director, Major Reed G. Landis, famous American pilot of the first Great War.

The first and most important task of the aviation aide lies in the organization of the Civil Air Patrol which is prepared to enroll all persons qualified as flyers, owning their own planes and wishing to give service to the nation. It is easy to enroll. There is no specific examination and a man who is a pilot but has no airplane may act as co-pilot for a pilot-owner. Special training will be given to the enrollees in military and naval air tactics, navigation, air raid warning service, and similar tasks.

Perhaps the most important question to be asked by people wishing to enroll would be: "What are the services that the Civil Air Patrol could render in national defense?" These are enormous and important. To begin with, they might guard all airports, and the guarding of airports has been proved to be vitally important by the events in Hawaii and the Philippines; and there are two thousand airports to be guarded in the United States. Courier service may be of great importance to the Army. No matter how many military pilots and planes we may have, observation patrol of back country areas is likely to be desirable. C.A.P. pilots may be required to tow aerial gunnery targets, thereby releasing military equipment for more important duty. C.A.P. personnel, familiar with all types of aircraft, can assist the air raid watchers. Highway traffic control from the air may, at times, be of value. When a military aircraft is forced down, the new organization may help to find them.

Obviously, not all of the possibilities of C.A.P. are yet understood, but the Army is backing the new organization to the fullest extent.—*A. K.*

ICE

Combatting a Scourge of the Upper Air

ICE is prevented from forming on the windshields of airliners operated by United Air Lines by a system which has been 18 months under development and has proved completely satisfactory.

The windshield used in this system consists of a front pane of quarter-inch safety plate glass and a rear pane of eighth-inch transparent plastic, with a quarter-inch air space separating the two. Air, heated to 175 degrees, passes through a duct from the plane's cabin heating system, on through the air space of the windshield, and then through an exhaust duct to the outside of the plane. The air, controllable by the captain through the operation of a valve at his elbow, moves at the rate of 60 cubic feet per minute. In installing the double windshield, 10 by 35 inches, on the captain's side of the cockpit it has become possible to eliminate the small vertical post which has been standard between the large fixed panel and small sliding panel of the DC-3 windshield, thereby providing the Captain with unobstructed vision. It is noteworthy that J. A. Herlihy, Executive Vice-President of United, tried fluids, windshield wipers, and the application of heat to the inside of the windshield before deciding on the system now being installed.

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

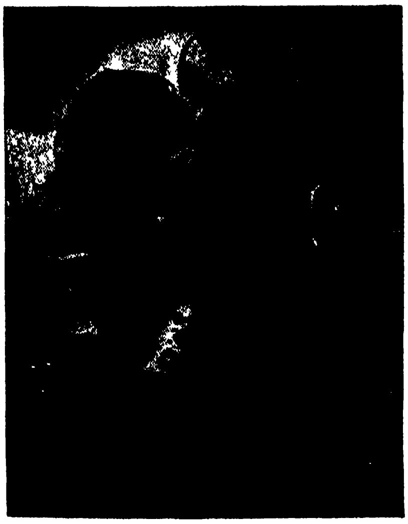
The Camera Enlists

FREQUENT requests have come to us recently asking how photography amateurs can do their bit in the defense effort. Individual instances will vary but, as we see it, the opportunities are twofold: educational and publicity. Defense workers in various branches of activity must be taught how to perform their duties most efficiently, and publicity concerning these activities must be spread, in order to inspire non-workers to enlist part of their leisure time in some phase of defense work.

Publicity pictures, therefore, should demonstrate the many ways in which lay persons may help in one or another of the many branches of defense work. Also, they have the equally important benefit of advising the general public as to how public and defense workers must co-operate when the time comes—air raids, fires, and so on.

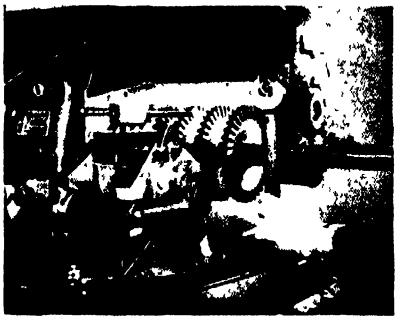
It is in the educational field, however, that the greatest opportunity lies. Volunteer services form the bulk of many defense activities. This means lack of experience or skill and, in frequent instances, even lack of knowledge. Volunteer teachers instruct the tyros, but this is slow work at best. A picture tells a thousand words, and even the best of teachers can do his or her job better if pictures or slides are used to supplement the lesson. In fact, a good set of pictures illustrating a task, step by step, in clear, sharp images placed where they receive good illumination, often can substitute for a teacher entirely, which means fewer teachers, more workers, and a wider dispersion of knowledge among many scattered groups. Paucity of teachers would have no meaning because you would not need them; all you would have to do is strike off duplicate sets of prints.

The power of the pictured lesson is well realized by the United States Office of Education, which is now in the process of directing the production of 50 reels of sound films covering various phases of machine-shop work. These are being reproduced in 16mm size and distributed, for the most part, to vocational schools and in industries where machine-shop training is being given.



Learning by seeing

By the nature of the assignment, educational pictures made with the still camera must show the details of the task as clearly as possible. This means close viewpoints, sharp focus, small diaphragm openings, and generous illumination with full exposure. From such negatives enlargements must be made that have good contrast throughout with adequate shadow detail. The size of the enlargements will vary in accordance with the requirements; for small groups perhaps 11 by 14 inches will do, for larger groups 16 by 20-inch prints may be needed. The slide would do the trick best of all, but the disadvantage here is that you must have a projector and a screen, whereas ordinary prints may be simply set on an easel and adequately lighted.



The movie camera teaches

The slide and the motion-picture film can tell a story more efficiently than the still picture, it is true, but there is this point also to consider: projection implies a darkened room which means that during the showing, the student can only watch and take mental notes. In the case of prints, however, a series of prints may be lined up on a wall to illustrate a practical sequence in some craft, and the student may actually build, or sew, or whatever, in accordance with the instructions indicated in the prints.

However, various crafts call for different approaches, and whereas in one case the print sequence would do the trick; in another, more complicated instance—as in the case of a machine-shop operation—the movie would be the more practical method of teaching.

When Condensers Are Scratched

THE plano side of a double condenser system is always subject to abrasions, particularly if it is of the type too large to be fixed in place. In one instance, such a condenser was injured

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when it was being replaced with a smaller condenser unit for small negative work. This scratch showed up beautifully on every print projected with that particular condenser unit in place. This was obviously to be expected since the scratch was on the plano side of the condenser lens closest to the enlarger lens, therefore projecting on the easel almost as sharply as the negative itself. The remedy was to reverse the two condenser lenses in the condenser case, placing the good one on the bottom and the scratched one on top. The scratch was so diffused that it made no impression on the print.

Candid's Still With Us

"You can't take a picture in this light", said our table companion, to which we replied: "That's what you think," and went ahead and did it. The result is reproduced, an honest-to-goodness candid shot of a lad in a listening mood.

"The Problem"

The illumination was from a 100-watt bulb in the ceiling, reflection from the white tablecloth helping to fill in the shadow areas. Made with an Automatic Rolleiflex on Plus X film, the exposure was *f*/3.5 at 1/10 of a second.

Retouching Easel

A 14 by 17-inch unfinished wood picture frame found in an art store gave Mrs. Flora K. Howes, of New York City, an idea for a retouching stand. She bought the frame and had the frame maker build her another frame 14 inches square. The two were then hinged together, the square frame, serving as the bed of the easel, having a white card set in it for reflecting the light to the glass in the easel. A strut attached to each side of the bed held the easel upright at the desired angle. The easel was fitted with a 14 by 17 sheet of ground glass. When not in use the device easily folds up and occupies little storage space.

Easy Road to Composition

Composition is the bugaboo of most photography amateurs, although its basic principles are simple enough. In a recent one-man show in New York City, W. M. Westervelt, a teacher of photographic design and a member of the art staff of an advertising agency, demonstrated by a group of abstract studies that composition is simply a matter of working within a definite area to achieve "a comfortable picture."

"When I want to figure out how to get an interesting shot of some small object," he explained, "I set it down on a table, put one spotlight on it, and then I walk all around it, looking at it through a rectangle 2¼ by 3¼ inches in an 8 by 10-inch piece of cardboard. I never look at my subject matter except through this cardboard viewer. You can't compose just in general; you have to compose within a definite area."

Print Reducer

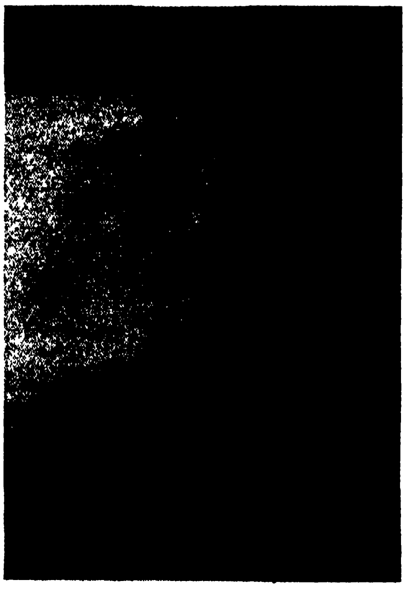
For toning down local areas in prints with distracting highlights and other spotty areas, the following formula has been successfully employed:

Solution A:	
Sublimated iodine	20 ozs.
Alcohol	10 ozs.
Solution B:	
Thiocarbamide	1 oz.
Water	10 ozs.

For rapid action use five drops each of Solutions A and B. Slower action is recommended, however. This calls for the use of five drops of A to 10 drops of B. The solution is applied with a bit of cotton on the end of a toothpick. As soon as applied to a particular spot, the area is immediately swabbed with a wad of cotton dipped in alcohol. The routine is repeated as often as necessary to achieve the desired tone.

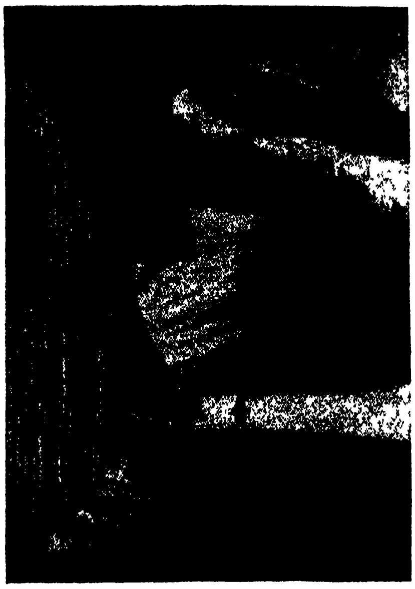
Helps to Perspective

A picture in the distance, but only space in the foreground: How to shoot that distant picture without being handicapped by empty foreground? That was the problem facing LeRoy Roselieve, New York ski enthusiast, who invariably totes an Ektra with him wherever he goes, shooting Plus X. The long shadows


"Up Again"

in "Up Again" saved the day by darkening the foreground mass, which served also the auxiliary purpose of continuing the "frame" provided by the trees. The result gives an excellent idea of distance, which would have been killed by a white foreground.

In "Haven," meaning is lent the ski paraphernalia leaning against the wall by the distant figures and ski slopes. Here the interest lies chiefly in the foreground, but without the distant scene the subject-matter would lack completion. Situations like these provide opportunities for introducing some of the tricks and methods by which photographers attempt to give their pictures the three-dimensional values they always strive for.



"Haven"

New Infra-red Material

An accidental observation by Dan Grossi, of the Wabash Photolamp Corporation, resulted in making available an infra-red emulsion which, when used with blackout flash illumination, is said to have a speed much greater than that of regular infra-red film. The film (made by Eastman) had previously been used exclusively for aerial infra-red photography. A piece of the film was cut up into 4 by 5 sheets for use experimentally. The results were so phenomenal that efforts were made to have Eastman furnish a regular supply. So now we have Infra Red Safety Film, Aero Type II, at present in size 4 by 5 inches only. At this writing, the emulsion is coated on thin Aero base, but Eastman plans shortly to use a heavier base similar to that used for other cut film.

Estimates of the speed range from three to 10 times the regular infra-red speed. We have not attempted to test the speed as yet, but results we have seen indicate that a negative of good density can be made outdoors at night with stop *f*/8 at a distance of 15 feet, shutter at 1/25 of a second.

Because the film is rather perishable, said to be good for only 60 days, the manufacturers recommend it be kept in the icebox when not being used. Due to this factor, also, film is ordered by the dealer for each customer. The film is sent by Eastman directly to this customer; the dealer bills the customer. This assures that the user will get the film without any delay.

Readers who desire further information on the subject of blackout flash work in general are referred to this department in the October, November, and December issues. Here they will find details on bulbs, exposure time, and so on.

• • •

What's New

In Photographic Equipment

Albert President Tripod ($25): Built-in swing camera platform permits vertical angle or horizontal shots with turn of knob. Adjustable camera screw fits all cameras. Leg tips reversible from points to rubber Made of three-section tubular steel Complete with tilt-head, weighs five pounds. Leg-lock adjustable from 28 to 62 inches.

"Flicker Frolics": New series of home movies produced by Official Films. First subject "The Race for Life," described as an old-time slapstick melodrama, with Mabel Normand, Mack Sennett, Ford Sterling, the Keystone Cops, and Barney Oldfield.

Da-Scope Kodachrome Viewer ($1.95): Folding slide viewer with translucent white plastic top, on which slide is mounted when viewer is open, permitting diffused illumination. Viewing lens magnifies image. Device measures 2⅝ by 2¼ by ⅞ inches.

"Britain's Commandos in Action!": Castle film record of raids by Britain's suicide squads on two Nazi-held Norwegian islands, available for users of 8mm and 16mm projectors in five sizes and lengths.

Agfa Finex Fine Grain Developer (now available in quart size at $1.75): Through recommended laboratory replenishing system, quart permits total of 60 rolls of 36-exposure miniature (35mm) film or 60 rolls B2 or 120 rolls, or equivalent, to be developed. Finex Replenisher sold separately at 75 cents an 8-ounce bottle.

Hollywood Titler ($9.75): Title cards may be photographed at 4, 6, 8 and 12 inch distance. For 8mm and 16mm camera users. Permits making zoom and superimposed titles; accurate alignment with custom-made camera base for your particular camera. All parts adjustable on base, permitting use for table top, copy work and extreme close-ups. Complete with two auxiliary lenses, celluloid target, instructions and titling data. Professional attachment ($5 50) makes possible turnover, turnabout, turnaround, flop up and down, revolving, and other titling tricks.

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Current Contributions on Insect Control is a brief report on recent findings with respect to the control of insect pests of fruits, vegetables, and ornamental plants. *New York State Agricultural Experiment Station, Geneva, New York.—Gratis.*

Plexiglas Fabricating Manual is a 48-page booklet prepared specifically for organizations fabricating Plexig'as for defense purposes It is of immediate interest, however, to other users of thermoplastics. The text of the booklet covers such phases of the work as machining, forming, cementing, finishing, and repairing. A large number of illustrations supplement the text *Rohm & Haas Company, Washington Square, Philadelphia, Pennsylvania.--Gratis.*

Phosphates on the Farm, by Chester F. Hockley, is an eight-page pamphlet which deals with the whole problem of phosphatic fertilizers as used in modern agriculture. Emphasis is placed not only on the phase of plant nutrition but also on that of farm animals which are fed products of the soil *The Davison Chemical Corporation, Baltimore, Maryland.—Gratis.*

Hand Pumps is a 4-page illustrated bulletin describing high-pressure pumps for testing purposes and for operating jacks and small hydraulic tools. Pressure capacities of the pumps range from 1,500 to 30,000 pounds per square inch. Ten different types are illustrated and mechanical characteristics are tabulated. *The Watson-Stillman Company, Roselle, New Jersey.—Gratis.*

On the Pipeline Front is a 12-page booklet devoted to a description of the pipeline industry. The text tells the dramatic story of the men and machines composing this industry which is contributing greatly to the progress of commercial and domestic life all over the world. *Form 7218. Caterpillar Tractor Company, Peoria, Illinois.—Gratis*

Electron Microscopes and Their Uses, by Joseph A. Becker and Arthur J. Ahearn, is a 16-page illustrated booklet which gives a bit of the history of microscopes in general and describes the design and construction of the modern electron microscope. Included are a number of reproductions of photographs made with this instrument, showing details never seen by men until the development of the electron microscope. *Bell Telephone Laboratories, Inc., 463 West Street, New York, N. Y.—Limited Free Distribution.*

Men You Like to Meet is a 24-page collection of short "human interest" stories about highway heroes—truck drivers whose everyday work is often correlated with an aura of glamor and romance *American Trucking Association, Washington, D. C.—Gratis.*

Band and Block Rubber Tracks is an eight-page bulletin which discusses the principles of these two types of tracks for vehicles, illustrates their differences, and tells of their advantages over the steel crawler type of vehicle. Data tables are presented for some of the factors involved. *The B. F. Goodrich Company, Akron, Ohio.—Gratis.*

Chemicals By Glyco is a 112-page book giving detailed information on a wide range of commercial chemicals, including suggested formulas for the manufacture of numerous finished products. Flame-proofing and waterproofing agents, synthetic resins, and waxes, emulsifying agents, and so on, are dealt with in detail.—*Glyco Products Company, Inc., 230 King St., Brooklyn, New York -- Gratis.*

Engineering Tables is a 12-page manual designed for hydraulic engineers and others in allied lines. Among the table headings are: capacities of hydraulic rams, discharge of water for circular straight edge orifices, strengths of materials, and useful hydraulic formulas *Bulletin No. 120-A The Watson-Stillman Company, Roselle, New Jersey.—Gratis.*

Shipbuilding Terms is a 64-page wire-bound book which presents the text of a course developed for defense training classes in the ship-building occupations The purpose of the text is to acquaint the reader with the meaning of ship terms, ship locations, and abbreviations of ship terms. *American Technical Society, Drexel Avenue at 58th Street, Chicago, Illinois —50 cents.*

Radiotron Designer's Handbook is a 365-page bound volume designed for radio engineers, amateurs, experimenters, service men, and others interested in the principles of practical circuit design. The text is divided into eight chapters covering the fundamentals of the subject. There are a number of illustrations and numerous reference charts and tables. *Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, New Jersey. -$1.00.*

Electronic Control is a technical reference bulletin covering resistance welder heat-controls, synchronizers, synchronous timers, and power and control units for welding equipment and automatic machinery of various types and capacities. *Weltronic Corporation, Detroit, Michigan.—Gratis.*

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Dr. Plaskett's detailed account of the acceptance tests for the great 82" mirror for the McDonald observatory, reprinted from *Contributions from the McDonald Observatory, University of Texas*, begun here last month, is concluded as follows:

The focal length of the completed mirror was carefully measured before the reductions of the final measures, as 319.656", or 811.928 cm; and with this focal length the intersections of the 12 zones used in the visual tests and the 15 in the Hartmann test were computed anew, and are given in Table 1. On the left-hand side the units are inches and on the right centimeters, as the separation of the zones, which are those of the diaphragm used in the Hartmann test and the pitch of the screw used in measuring the photographs, are given in these units. The recomputation was necessary, as the difference between these positions and those for the focal length of 320" amounts to 0.005", or 0.12 mm, which is quite significant with so good a mirror as the 82".

The visual measures of the intersections of the pencils from the various zones were made on October 12 and October 14, immediately after the parabolizing was completed, and again on October 25 and November 1, after the mirror was aluminized. There were four independent sets of measures on October 12 and six each on the other three dates, equally divided between, and alternated by, Mr. Lundin and myself. The separation of the scratches was measured by dividers on a steel rule divided into fiftieths and hundredths of an inch. These measures, or rather the differences between the observed and the computed position ΔR, are given in thousandths of an inch; for, although in a single setting three places are not significant, they more nearly approach it in the mean of four, and still more of six settings. The probable errors of the mean of six settings is 0.0022" for the outer four zones, 0.0038" for the intermediate, and 0.0043" for the inner four zones.

The results of these four measures are given in Table 2, where the first column contains the zone number, the second and third and the succeeding three pairs of columns give the ΔR's, the difference between the observed and computed positions of the zonal intersections, and their transformations into the curve of shape for the four dates. It will be noted that the values of ΔR which, it must be remembered, are expressed in thousandths of an inch and are four times the longitudinal aberrations at the principal focus, vary somewhat on the different dates, being lower on October 12 and 25 than on October 14 and November 1. While the accidental errors of the means of the sets, varying from ±0.002" to ±0.004", and increasing from edge to center of the mirror, may account for a considerable fraction of the variation, there may be something systematic about the differences, such as temperature variations on the different dates, or change of figure produced by irregularities in the thickness of the aluminum coating.

So far as the latter effect is concerned, it may be dismissed as negligible, as there is no appreciable systematic difference in the run of the ΔR's before the coating, on October 12 and 14, and after it, on October 25 and November 1. There may be, however, some evidence of a temperature effect on the figure of the 82" mirror. On October 12 and 25, when the variations in the ΔR's were somewhat smaller than in the other two measures, the decrease in temperature, taken from a thermograph near the mirror, between midnight and the time of the tests, about 11:00 A.M., was 1°.2F, while on October 14 the change was 2°F. However, on November 1 the temperature was constant within 0°.3F, so that, on the whole, a variation of figure with small temperature changes is not demonstrated.

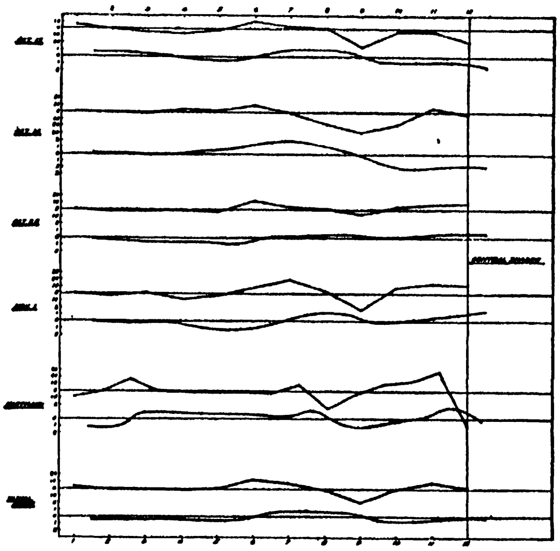

Figure 3: Final test. Upper curves of the ΔR's. Lower curves are the curves of shape

We may, hence, consider that the variation in ΔR's are mainly accidental and use the mean values of the 22 different settings as best representing the figure of the mirror, and these means are given in the last three columns of Table 2. The mean ΔR's are all remarkably small, less than 0.004", or 0.001" at the principal focus, except for zones 6, 9, and, to a smaller extent, 11. These indicate only a very small deviation from a perfect figure, the maximum longitudinal aberration at the principal focus in the last column being 0.005", or 0.12 mm, as compared with the 0.4 mm allowed by the specifications. The total area of the three divergent zones is only 15 percent of the area of the surface, so the effect on the resultant image will be small. The maximum diameter of the circle of confusion, computed geometrically from the largest longitudinal aberrations, is 0.014 mm, as compared with the 0.05 mm of the specifications. Furthermore, 85 percent of the light is concentrated in a diffusion disk of an average diameter less than one-third the foregoing.

The ΔR's from Table 2 are represented graphically in Figure 3, the scale divisions being in hundredths of an inch, although numbered in thousandths (these being used rather than millimeters since all the measures were more conveniently

ZONE	RADIUS OF ZONE (IN.)	DIFF. RADIUS (IN.)	ZONE	RADIUS OF ZONE (CM)	DIFF. RADIUS (CM)	HARTMANN MEAS.		MEAN ASTIGMATISM (MM)
						ΔR	ΔF	
1......	40.250	2.539	1....	101.5	6.365	−0 32	−0 08	+0.11
2......	37.711	2.229	2....	97.	5.808	−0.11	− 03	+ .06
3......	35.211	1.942	3....	92.	5 224	+0 36	+ 09	− .03
4......	32.721	1.677	4....	87.	4 653	−0.11	− .03	+ 04
5......	30.227	1.431	5....	82.	4 149	−0 15	− .04	− 01
6......	27.736	1.204	6....	77.	3 658	−0 16	− 04	− .02
7......	25.231	0.996	7....	72.	3.206	−0 12	− 03	+ 07
8......	22 727	0.809	8....	67.	2.776	−0 17	− .04	+ 08
9......	20.231	0 641	9....	62.	2.374	+0 13	+ 03	+ .01
10......	17.738	0 492	10....	57.	2 007	−0 72	− .18	+ 01
11......	15.217	0.362	11....	52.	1 671	−0 22	− 06	+ 01
12......	12.744	0.254	12....	47.	1.363	+0.15	+ .04	− .02
13......	10.277	0.165	13....	42.	1.090	+0.24	+ .06	+ 08
14......	7.729	0.093	14....	37.	0.846	+0 62	+ .15	− .10
Center..	0	0	15....	32.	0.632	−1.34	−0.33	−0.06

Table 1: Positions of Intersections (max. diam., 0.025 mm)

made in those units). The curves of shape computed from these ΔR's are given immediately below each curve of ΔR, the units here being millionths of inches. The maximum departure from the mean paraboloid in the lowest curve is 0.0000007", considerably less than a twentieth of a wave.

The Hartmann Test: There remains one further test of the surface, the well-known Hartmann test, which was requested by the purchasers early in the negotiations, the diaphragm being made according to their specifications. The latter contains 60 holes, each about 38 mm in diameter, spaced along twelve radii 30° apart. The holes cover 15 zones of the surface twice, the two sets being 90° apart to determine the astigmatism. The radii of the zones are given in Table 1 in centimeters, successive zones being 5 cm apart except that the distance between No. 1 and No. 2 is 4.5 cm. This diaphragm was placed directly over the aluminized mirror, which rested on the table of the polishing machine and was turned into a vertical position for both visual and photographic tests.

Several precautions were taken to insure reliable results on these tests The principal difficulty encountered in my earlier tests of the 72" Victoria and the 69" Delaware mirrors had been temperature stratification in the Brashear testing chamber. This difficulty was much less troublesome at Cleveland, owing to the better temperature correction and to the tests being made in an open room instead of the closed 6' square tube at Allegheny. Nevertheless, it was still present, as the images of the zonal apertures on the plates were all elongated in the vertical direction. To overcome as much as possible such temperature difficulties, the mirror was always kept horizontal, except for the few minutes the photograph was being made, so that it must have been at practically constant temperature throughout. Four exposures were made in each set, the mirror being rotated 90° each time, so that the longitudinal aberrations and the astigmatism could be tested not only from the two sets of apertures on each plate but also from the horizontal sets only, on successive plates, in the hope of overcoming stratification effects.

The four plates yielded four determinations of the ΔR's and four of the astigmatism. The average probable errors of the mean values, which, unlike the visual settings, did not increase in the inner zones, was ±0.21 mm, which, compared with the visual average of ±0.082, makes the photographic probable error over 2 5 times greater than the visual. The values of the photographic ΔR's and of the longitudinal aberrations at the focus are given in the seventh and eighth columns of Table 1 These, reduced to the same scale as those of the visual tests, are shown graphically in the fifth group of Figure 3 Although these show a trend similar to the visual graphs, they are naturally, owing to the higher probable errors, considerably more ragged and are entitled to considerably less weight.

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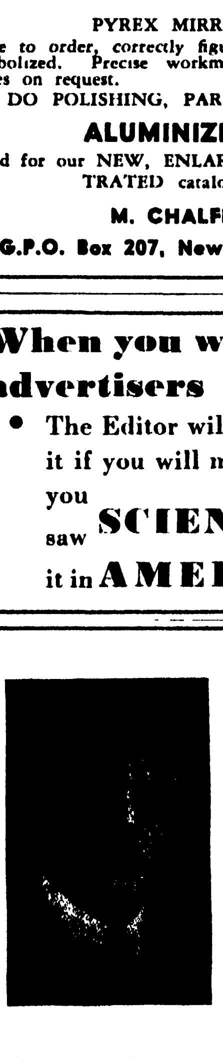

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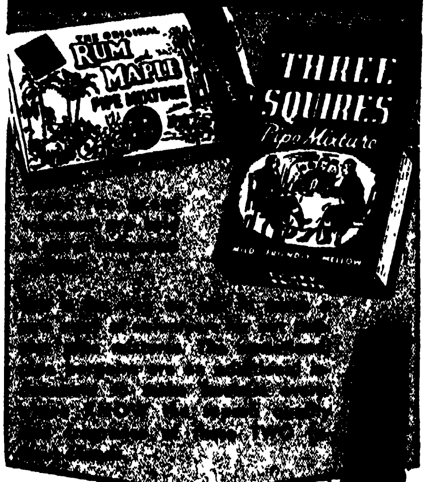
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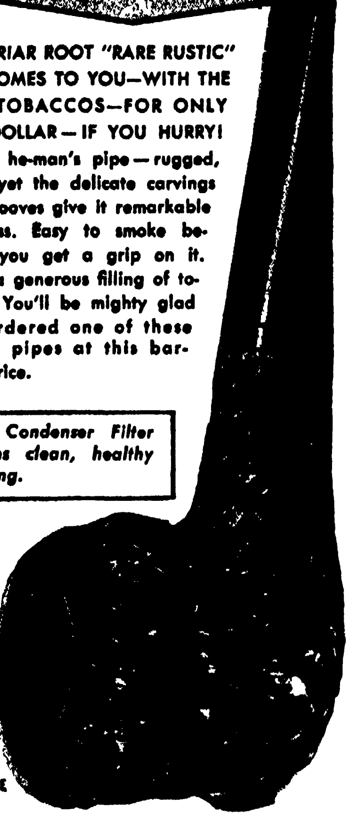

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Zone	Oct. 12		Oct. 14		Oct. 25		Nov. 1		Mean ΔR	Mean Curve	ΔF at Focus (Mm)
	ΔR	Curve	ΔR	Curve	ΔR	Curve	ΔR	Curve			
1....	+0.006	+0.7	−0 001	+0.1	+0.001	−0.1	0.000	0 0	+0 0035	−0.4	+0.02
2....	− .001	+0.6	.000	+0.1	− .002	− .4	− .003	−0.3	.0000	− .4	.00
3....	− .005	+0.2	− .001	0.0	− .001	− .6	+ .001	−0.2	.0000	− .4	00
4....	− .007	−0.4	+ .005	+0.5	.000	− 6	− .008	−1.0	− .0022	− .5	− .02
5....	− .003	−0.5	+ .003	+0.8	− .003	− 9	− .003	−1.3	.0000	− .5	.00
6....	+ .011	+0.6	+ .011	+1.7	+ .013	+ .2	+ .009	−0.5	+ .0125	+ .6	+ .08
7....	+ .003	+1.0	− .001	+1.6	+ .004	+ .4	+ .020	+1.0	+ .0008	+ .7	+ .01
8....	+ .001	+0.7	− .016	+0.5	+ .002	+ .5	+ .004	+1.1	− .0015	+ .6	− .01
9....	− .025	−0.7	− .023	−1.2	− .006	+ .1	− .023	−0.3	− .0190	− .6	− .12
10....	− .004	−0.8	− .017	−2.1	+ .004	+ .3	+ .009	+0.2	− .0005	− .6	.00
11....	− .004	−0.8	+ .007	−1.8	+ .008	+ .6	+ .014	+0.8	+ .0078	− .2	+ .05
12....	−0.019	−1.4	−0.003	−1.9	+0.010	+0.6	+0.012	+1.5	+0.0015	−0.2	+0.01

Table 2: Visual measurements of Δ R (max. diam., 0.014 mm)

of astigmatism. The mean differences between the longitudinal aberrations at the principal focus in two azimuths on the mirror 90° apart are given in the last column of Table 1. If not wholly due to accidental errors, as seems likely from those determined above, there is certainly no systematic trend of the signs, the algebraic mean being only +0.02 mm, and it may be safely said that the surface is free from astigmatism.

The Hartmann criterion T, obtained from the formula

$$T = \frac{200{,}000}{F_0^2}\cdot\frac{\Sigma r^2\Delta F}{\Sigma r}$$

where F_0 is the focal length, ΔF the longitudinal aberration at the principal focus; taken without regard to sign, and r the radius of any zone, simply gives the weighted mean value of the diameter of the geometrical confusion circle expressed in terms of $F_0/100{,}000$, while $2.0626T$ is its apparent diameter in seconds of arc. The values of T were computed for each of the four visual measures and for the single photographic test, and are given in Table 3. This was done for completeness only, as the value of T obtained from the mean of the 22 visual measures of ΔR at the center of curvature (given in the last line of Table 3) is obviously of much greater weight and is taken as more truly representing the optical qualities of the mirror The maximum diameter of the diffusion disk was calculated above as 0.014 mm, less than one third the 0.05 mm permitted by the specifications, but is nevertheless nearly four times larger than the average diameter of 0.0039 mm in the last line of Table 3. There is, however, such a small proportion of the total light entering into this expanded disk that, in comparison to the central condensation, it will be quite inappreciable.

It will be of interest to compare the optical qualities of the 82" mirror with those of other large reflecting surfaces which have been similarly tested. For this purpose the criterion T forms the best guide, as the errors or aberrations and the diameter of the geometrical diffusion disks are directly proportional to T. The following list comprises all those known to me, as the Mount Wilson 60" and 100" mirrors have had, to the best of my knowledge, no measures of their aberrations published

72-inch Victoria mirror[1]...... T = 0.12
69-inch Delaware mirror[2] .... T = .14
74-inch Toronto mirror[3]... .. T = .20
82-inch Texas mirror.... .... T = 0 050

Not only has the Texas mirror much smaller measured errors than any other, but such a relatively large proportion of the figuring was performed with large tools that the surface must be remarkably smooth and regular This was, indeed, amply demonstrated by the Foucault and Ronchi tests, and it can be safely stated that the quality of the 82" mirror of the McDonald Observatory is unequaled by any mirror previously made and tested

---

[1] Computed from the aberrations published in *Pub. Dom. Ap Obs*, 1, 41, 1920

[2] *J Opt Soc Amer*, 23, 293, 1933.

[3] *Pop Astr*, 44, 349, 1936.

Kind of Measure	Date	Number of Measures	Hartmann T	Weighted Diamfter of Geometrical Diffusion Disk	
				Millimeters	Seconds
Visual........ ...	Oct. 12	4	0 080	0 0064	0.17
Visual........ . .	Oct. 14	6	.070	.0052	.14
Visual....	Oct. 25	6	.042	.0032	.09
Visual...	Nov. 1	6	.085	.0068	.18
Photographic......	Oct. 26	4	0 100	0.0078	0 21
Mean of all visual measures.	....	22	0.050	0.0039	0.10

Table 3: Results of the tests

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THE reason why aluminum has become such a choke-point in the present-day scheme of things is put forth in detail in the article starting on page 232. Our cover photograph shows molten aluminum being poured into molds from a ladle which has been filled from an electrolytic cell.

●

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SCIENTIFIC AMERICAN, May, 1942, Vol 166, No. 5. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879; additional entry at Albany, New York, Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City. Copyright 1942 by Munn & Co, Inc., Great Britain rights reserved "Scientific American" registered U. S. Patent Office. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage. Illustrated articles must not be reproduced without written permission; quotations therefrom for stockselling enterprises are never authorized Files in all large libraries; articles are indexed in all leading indices. Subscription rate $4 00 per year. Canada and foreign $5.00.

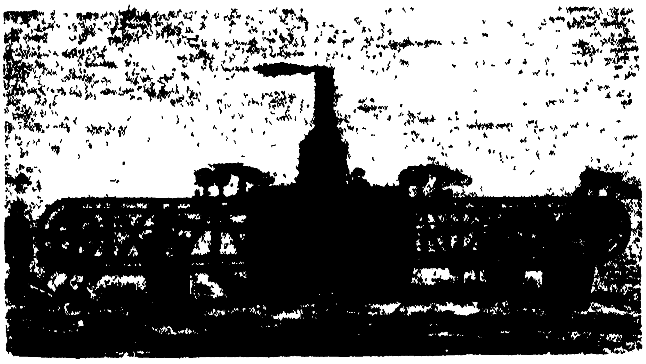
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of May, 1892)

RECLAMATION—"The business of securing waste rubber and recovering it obtained its impetus soon after the expiration of the Goodyear patents. Before that time the scrap, particularly that which was vulcanized, had been burned under the boilers or thrown away. . . . Briefly described, the process of reclaiming old rubber boots and shoes is as follows: The boots and shoes are roughly torn to pieces. These go to a grinding mill with a very decided friction motion which grinds the product to a fine powder . . . The black powder is next put in iron pans, run into a vulcanizer and exposed to live steam for a number of hours at a temperature varying from 400° to 600° F. . . . Taken out of the vulcanizer, it may be put on a grinder, when it will readily form in sheets, and has very much the appearance of compounded stock that is unvulcanized. . . . There are few lines of goods in which recovered rubber cannot be used."

PLOW—"The accompanying cut, which is from a photograph taken while the machine was in operation, represents the rear view of a steam plow designed and manufactured by an engineer who has had some 18 years experience in steam cultivation and steam drainage in England, Germany, and Russia, and with every known system. The apparatus is doing some excellent work, and is not only a working but a commercial success As much as three acres per hour have been plowed in a most excellent manner, and the average of a day's work may be set down at 20 acres, which is being done at a cost of 45 cents per acre."



GUNS—"The largest of the modern high-powered guns, entirely of American manufacture, thus far completed, are the two 12-inch guns for the Monterey, the new monitor now nearly finished at San Francisco, and these pieces, as they were assembled at the Washington gun factory, were believed by our very competent ordnance officials to be equal, if not superior, to the best guns of the same caliber made anywhere else in the world"

PIGEONS—"Some important experiments have been recently made at Portsmouth relative to the use of carrier pigeons at sea. . On one occasion there was a thick fog on the other side of the channel; the pigeons set free circled for a few minutes around the boat, and then, getting their bearing, returned home."

COMET—"Prof. Lewis Swift, of Warner Observatory, reports a dispatch dated San Francisco, quoting Prof. Barnard as saying that his recent observations of the new comet reveal a remarkable state of affairs. Spreading out from the head is a complicated system of tails. At least a dozen distinct branches can be counted."

ELEPHANTS—"An elephant's digestive functions are very rapid, and the animal, therefore, requires daily a large amount of fodder --600 pounds at least In its wild state the elephant feeds heartily, but wastefully It is careful in selecting the few forest trees which it likes for their bark or foliage But it will tear down branches and leave half of them untouched. It will strip off the bark from other trees and throw away a large portion."

MECHANICS—"A good mechanical eye is an almost essential requisite in a good mechanic. . . . No one can ever attain distinction as a mechanic unless he is able to detect ordinary imperfections at sight, so that he can see if things are out of plumb, out of level, out of square, and out of proper shape, and unless he can also detect disproportioned or ill-shaped patterns. . . . A little training and care is all that is necessary for success."

SAW- "Carnegie, Phipps & Co., who have the government contract for a portion of the armor plates of the new navy, are to add to the finishing plant of the armor department, a gigantic saw, weighing 110 tons, that will cut a nickel steel armor plate as an ordinary saw does a plank . The saw has a blade 7½ feet in diameter, geared from above and revolving horizontally With it an angular slab of cold nickel steel, weighing perhaps a dozen tons is taken off like the slab of a pine log."

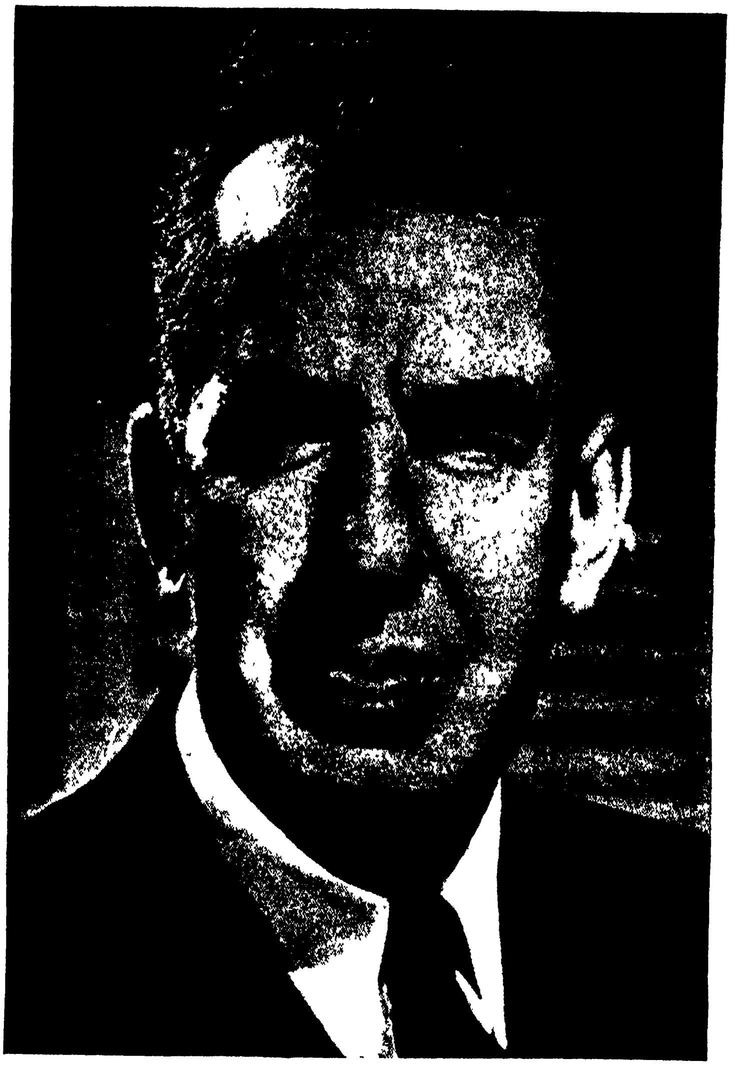
HIGH-SPEED PHOTOGRAPHY—"In a lecture on photographing bullets, delivered recently at the South Kensington Museum Professor C V Boys explained his apparatus for the purpose It consists of box lined with black cloth, in which the photographic plate is exposed, of a condenser, and of a system of wire circuits and knobs to give the spark which throws the shadow of the bullet on the plate, and thus takes the photograph The bullet enters and leaves the box by two holes, covered with paper to exclude the light, and in passing the plate the bullet touches the terminals of two wires, composed of thin lead wire, thus partly completing the circuit, causing a flash to pass between the knobs of the plate condenser inside the box, and this flash, lasting less than one millionth of a second, takes the photograph of the bullet no lens being employed"

LAND AND WATER—"It is estimated that the area of the dry land of the globe is 55,000,000 square miles and the area of the ocean 137,200,000 square miles The volume of the dry land above the level of the sea is estimated at 23,450,000 cubic miles and the volume of the waters of the ocean at 323,800,000 cubic miles The mean height of the land above the sea is 2,250 feet and the mean depth of the whole ocean is 12,480 feet Of course these results are only approximate, but they help to render our ideas of these matters more definite."

FREIGHT FERRY—"The bold idea of ferrying loaded freight cars across Lake Michigan is soon to be put into practice A large propeller is under construction at Toledo which will have a capacity of 21 cars, and it is expected to tow a barge carrying 15 cars, making 36 cars, or more than an average freight train"

MASONRY DAM—"The largest masonry dam in the world has lately been completed in India, in connection with the new water works for the city of Bombay. It is situated 65 miles north from Bombay, and stretches across the Tansa Valley. The dam is about two miles in length; 118 feet high; 100 feet thick at its greatest depth; 15½ feet at the top"

Personalities • in Industry



A. W. HERRINGTON

RECENTLY elected president of the Society of Automotive Engineers, Mr A W. Herrington is the head of the Marmon-Herrington Company, manufacturers of specialized automotive equipment for civilian and military services, and chairman of the board of the Merz Engineering Company, a Marmon-Herrington subsidiary specializing in the manufacture of precision gages, instruments, and machines

Mr Herrington has an intimate acquaintance with military transport problems throughout the world, gained during World War I and since that time through frequent business trips to Europe, North Africa, and the Near and Far East A forceful character, a dynamic speaker, and an accomplished organizer, it is his announced purpose, during the coming year, to use the influence of his position as head of the Society of Automotive Engineers to help synchronize the efforts of the entire industry into one great force for American defense and the successful prosecution of the battle against aggressor nations

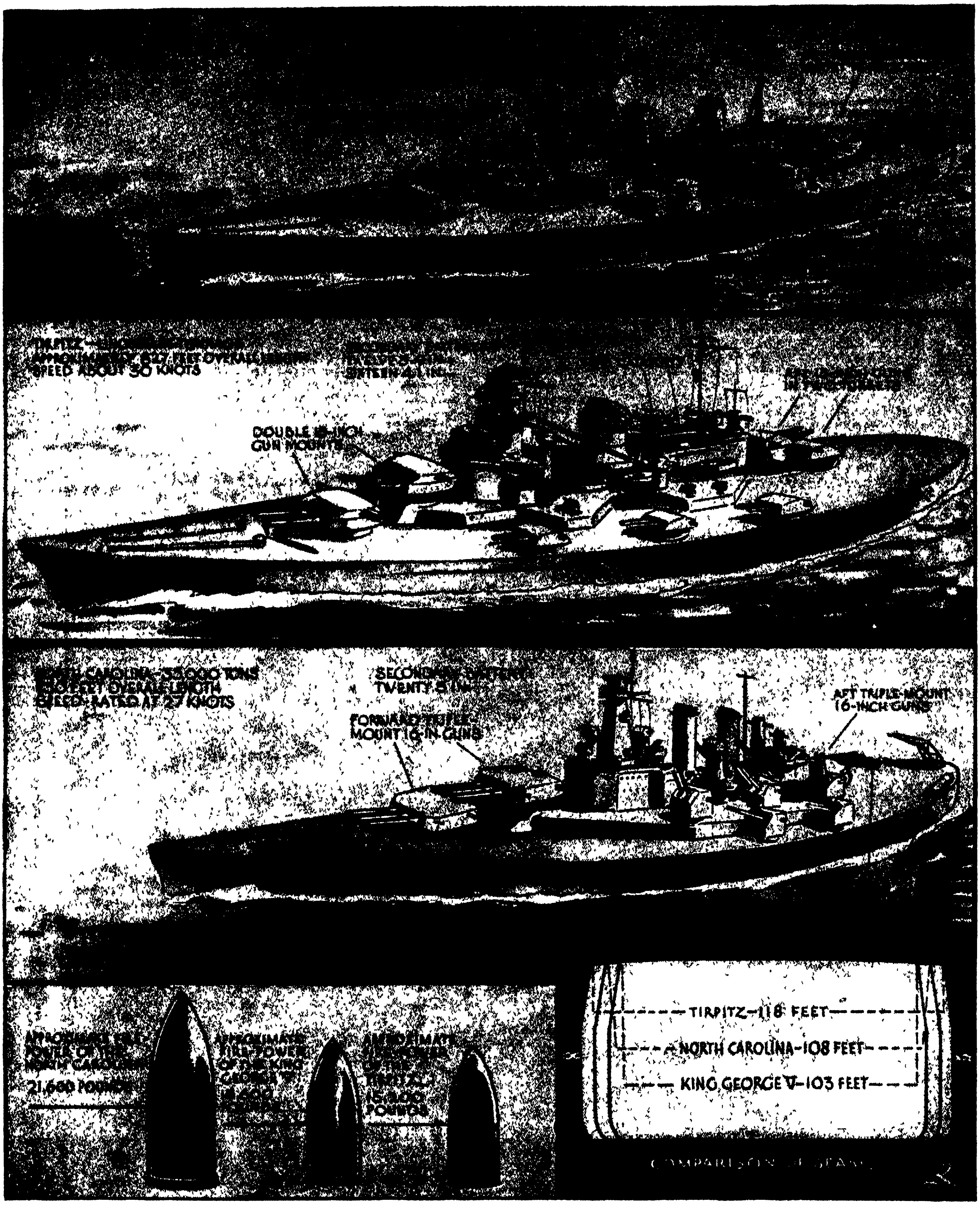
Born in Coddenham, England, Mr Herrington came to America at the age of five with his parents, Arthur and Mary Matilda Herrington. He was married in Richmond, Virginia, in 1924, to Nell Ray Clarke, a newspaper woman of Washington, D C He has one son, Arthur Clarke Herrington, now 10 Mr Herrington's primary schooling was received in Madison, New Jersey, and his technical education at Stevens Institute of Technology, Hoboken, New Jersey. His early automotive experience was gained with The Harley Davidson Motor Company, where he rose to the position of assistant chief engineer.

Mr. Herrington was in active service with the U.S Army in the World War from October 1917 to September 1919. It was during this period that he became impressed with the futility of conventional drive automobile equipment for off-the-highway military service and determined to do something about it Between 1921 and 1931, he was associated with several different motor car, truck and bus companies, and with the U S Army and Marine Corps as consulting engineer He is the designer of various military vehicles and is also the originator of the idea of converting standard mass-production trucks to all-wheel-drive

In March 1931 Mr Herrington became associated with the late Walter Marmon, as vice-president and chief engineer of The Marmon-Herrington Company at Indianapolis, Indiana, in the design and manufacture of high-traction automotive vehicles of all types, for the most difficult civilian services, such as in the oil fields, logging camps, and so on, and for military usage In August 1931 Mr Herrington became president of the company, Mr Marmon becoming chairman of the board.

As a result of his pre-war travels to far-away lands, Mr. Herrington's engineering ability is probably better known in such lands as Iran, Iraq, Australia, Africa, and China than here at home His huge all-wheel-drive trucks are serving the oil industry in the jungles of South America, in the tractless desert wastes of Arabia, and in other remote regions

Familiarly known to his friends and associates as "Colonel," Mr Herrington is a member of The Indianapolis Service Club, an organization of World War Veterans, and never fails to attend the weekly luncheon meetings when he is in town His interests, aside from business, are squash, lacrosse, yachting, deep-sea fishing, hockey, and big-game hunting He is a member of the Episcopal Church, a 32nd degree Mason, and a member of the Mystic Shrine His clubs are the Indianapolis Athletic and Columbia Clubs, the Woodstock Country Club, and the Gibson Island Club, Maryland He is also a member of the Society of American Military Engineers and a Fellow of the American Geographical Society.



Drawn by Logan U. Reavis especially for Scientific American. Approved by U. S. Navy

Battleship Types of Three World Powers

The comparisons of the three heaviest existing capital ship types of England, Germany, and the United States, given in the above drawing, indicate that the performance of the new *North Carolina* type may be awaited with confidence; in design, fire-power, and maneuverability it may, in some future encounter, justify the extraordinary care which has been exercised in its construction.

Resembling its ill-fated sister ship, the *Bismark*, it is probable that the *Tirpitz* is closer to a displacement of 50,000 tons than to the 35,000-ton figure usually assigned to her. Although the *Prince of Wales*, sister ship of the *King George V*, was somewhat punished by the *Bismark*, and later sunk by Japanese planes, it does not necessarily follow that this class is weaker than the *Tirpitz* under similar conditions Theoretically the *King George V* has the advantage of later research.

98TH YEAR SCIENTIFIC AMERICAN MAY 1942

DREADNOUGHTS OF THE U. S. NAVY

A Two-Ocean Fleet is Our Nation's Ultimate Goal

WALTON L. ROBINSON

EVERYONE realizes that the bitter conflict between the United States and Japan, particularly in its early stages, will be fought largely at sea and in the air. There has been and will be hard fighting on land, but before American and Japanese soldiers can come to grips on the battlefield they must first be embarked in transports and safely escorted by warships to the scene of operations. Seapower, from the very start, has played an even more decisive role in the Southwestern Pacific than it has thus far in European waters

For the past several years the United States Navy has been undergoing a rapid expansion toward its ultimate goal—a two-ocean fleet capable of repelling any likely combination of hostile powers in both the Atlantic and Pacific. This expansion continues at an ever-increasing pace, but now that war is actually here we must place our reliance in those ships which, fully manned by trained officers and men, are in every respect ready for active service. Warships in the blueprint stage or on the building ways never won a naval battle.

Early in December last, 17 American battleships, displacing 534,000 tons, were in commission, giving us the largest, though not the most up-to-date dreadnought force in the world Between them these ships mounted 178 heavy-caliber guns having a total broadside weight of 277,640 pounds Five of our ships were armed with 16-inch guns, eleven with 14-inch, and one with 12-inch. Great Britain followed with 13 battleships and two battle cruisers; while Japan, third largest of the world's sea powers, had 12 capital ships of some 385,000 tons and carrying 114 guns with a combined broadside weight of 186,460 pounds Four of Japan's ships were armed with 16-inch guns and the remainder with 14-inch The Imperial Navy also possessed three or four "pocket battleships" displacing around 15,000 tons and mounting six 12-inch guns each.

Mere statistics, however, cannot give an accurate picture of the relative fighting value of the American and Japanese battle fleets, for they fail to take into consideration such important factors as age, speed, armor protection, and hitting power of individual ships and the ability of each to operate in effective conjunction with the others. Our three oldest battleships are, for example, of very doubtful value, due primarily to their low speed and limited gun range, while several of Japan's are so scantily armored that a few hits from large caliber shells would certainly put them in serious trouble

NATIONAL DEFENSE

• This thorough-going analysis of battleships of the United States Navy is the first of a series of five articles, each complete in itself, which will give an accurate over-all picture of our naval strength in surface ships and submarines. —The Editor •

Our battleships range in size and age from the 26,100-ton *Arkansas*, completed in 1912, to the giant 35,000-ton *North Carolina* and *Washington*, which passed into service last year. Fifteen new battleships are completing afloat, building on the slips, or authorized. Several may be ready by the end of this year.

The *Arkansas*, our oldest and least valuable dreadnought, was built as a sister-ship to the *Wyoming*, which some years ago was demilitarized in accordance with the London Naval Treaty of 1930 and converted into a training ship. The *Arkansas* carries a main armament of twelve 12-inch guns mounted in six turrets disposed along her center-line. These guns, measuring 50 feet from breech to muzzle, hurl an 870-pound projectile at an initial velocity of over one-half mile per second. Due to their very limited elevation (15 degrees), however, they have an effective range of only some 15,000 yards, which is far below current requirements; and the *Arkansas*, were she to encounter a modern cruiser, might well find herself unable to get within range of her harder-hitting guns while, at the same time, suffering numerous hits from the cruiser's lighter but longer-ranged weapons.

The *Arkansas'* secondary or anti-torpedo armament consists of sixteen 5-inch, 51-caliber guns. These guns, firing a 50-pound shell, are of fairly modern design and constitute the secondary armament of all our battleships except the two newest. The anti-aircraft battery comprises eight 3-inch and numerous smaller guns. The 3-inch gun is inadequate for today's needs and in most of our battleships has given way to the more effective 5-inch, 25-caliber weapon.

ARMOR protection includes an 11-inch main belt along the water-line, 12-inch plates on the faces of the big-gun turrets, a 12-inch conning tower, and fairly thick decks over such vital spots as the engine and boiler rooms and shell and powder magazines.

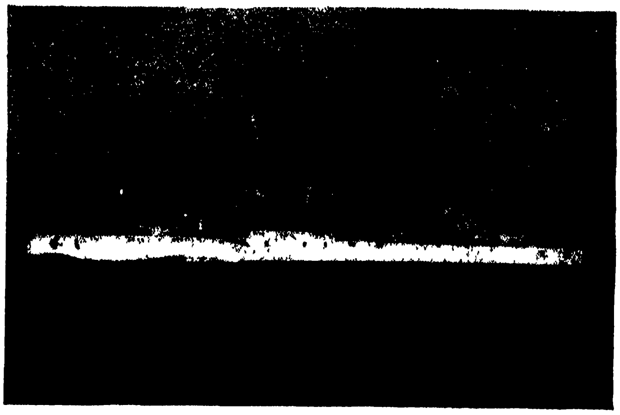
The *Arkansas* was designed to attain a speed of 20.5 knots, but can now do no better than 19 knots. This reduction was caused by the addition of anti-torpedo "blisters" when the ship was modernized some 15 years ago. Other alterations effected at this time included conversion to oil burning, stronger anti-aircraft defense, substitution of a tripod mainmast for the old cage or basket mast, and improved plane-handling arrangements. Three aircraft and a catapult are now carried atop No. 3 turret.

The *New York* and *Texas*, launched in 1912 and completed two years later, are our next oldest battleships. They displace 27,000 tons and are armed with ten 14-inch guns mounted in five center-line turrets. These guns are 45 calibers in length (that is, 52 feet, 6 inches), elevate to 15 degrees, and fire a 1400-pound projectile at a range of some 21,000 yards. Their secondary and anti-aircraft batteries are the same as those in the *Arkansas*. Armor protection includes a 12-inch water-line belt, 14-inch turret faces, thick decks, and a 12-inch conning tower. Anti-torpedo blisters, fitted some years ago, have reduced their speed to about 19 knots. Three planes and a catapult are carried on the amidship turret.

These ships are hard to handle and very poor sea boats in rough weather; they roll so badly, in fact, that waves frequently ride the blisters into the 5-inch gun casemates. One of the most interesting features of their design is the reversion to reciprocating engines in place of the turbines which had been fitted in the *Arkansas* and other earlier ships. This was done to show American turbine builders, who had refused to adopt the standards laid down, that the Navy Department was determined to have turbines built to official specifications.

The *Arkansas*, *New York*, and *Texas* are the "lame ducks" of our fleet and are no longer reckoned effective for war purposes. Judged by modern standards they are now quite obsolete and of little value as "line-of-battle" ships. Their presence in a major engagement might well prove a liability rather than an asset to our commander in chief, for their low speed and the limited range of their big guns would make it extremely difficult for them to operate with our faster and more powerful ships. Despite their deficiencies, however, these old battleships can still perform such secondary tasks as escorting convoys and attacking coastal objectives. They are hopelessly outclassed by Germany's trio of modern 30-knot battleships: the 35,000-ton *Tirpitz* (eight 15-inch guns) and the 26,000-ton *Scharnhorst* and *Gneisenau* (nine 11-inch guns).

The 29,000-ton *Nevada*, commissioned in 1916 as a sister ship to the *Oklahoma*, which capsized in Pearl Harbor last December 7, carries the same main armament as the *Texas*. Her 14-inch guns are differently arrayed, however, being grouped in two twin and two triple turrets with the former in the super-imposed positions. Moreover, they elevate to 30 degrees and have a range of some 30,000 yards. The *Nevada's* secondary and anti-aircraft batteries consist respectively of twelve 5-inch, 51-caliber and eight 5-inch, 25-caliber guns, plus numerous smaller weapons. She also carries three planes and two catapults—one on No. 3 turret and one on the quarter deck. Her secondary and anti-aircraft batteries and plane-handling arrangements are standard for all of our remaining battleships except the new *North Carolina* and *Washington*.



USS *Texas*, useful in convoy work

The *Nevada* and her ill-fated sister-ship marked a new era in naval construction, being the first dreadnoughts to embody the "everything or nothing" principle in the matter of protection. A 13½ inch belt, 400 feet long and 17½ feet wide, protects the water-line, 16- to 18-inch plates cover the turret faces, 16 inches encase the conning tower, and 3-inch upper and 2-inch lower decks provide defense against aerial bombs and long-range plunging shellfire. All this protection, less the horizontal or deck armor, weighs nearly 8000 tons.

The *Nevada's* designed speed of 20.5 knots, obtained by Parsons turbine engines developing 25,000 horsepower, was unaffected by the $7,000,000 modernization she underwent some years ago. The addition of anti-torpedo blisters, however, has made her unwieldly at low speeds. She and the *Oklahoma* were the first American battleships to be fitted with all-oil-fired boilers.

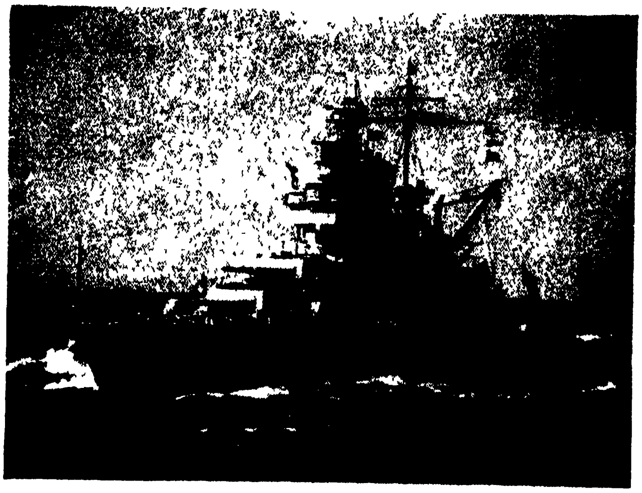
The *Pennsylvania*, launched in 1915 and completed the following year, is a sister-ship of the *Arizona*, which sank in shallow water at Pearl Harbor. Displacing 33,100 tons, the *Pennsylvania* is simply an enlargement of the *Nevada*, which in appearance she greatly resembles. She has two more 14-inch guns, heavier armor protection, and a somewhat higher speed. The increase in the number of big guns was made possible by placing three of them in each of the four turrets. The water-line belt is 14 inches thick and two decks, a 6-inch upper and a 3-inch lower, protect the ship's vitals. The speed of 21 knots is obtained by 32,000 horsepower turbine engines driving four screws.

The *Pennsylvania* is a splendid sea boat, offering a very steady gun platform, and has proved a most economical steamer. She has always been regarded as a fine ship and for many years served as flagship of the CINCUS (Commander in Chief, United States Fleet). Some years ago both she and the *Arizona* underwent an extensive reconstruction at a total cost of nearly $15,000,000. Among the alterations effected were the raising of the anti-torpedo battery from the main to the upper deck, the strengthening of the anti-aircraft armament, substitution of tripod masts for the old cage type,

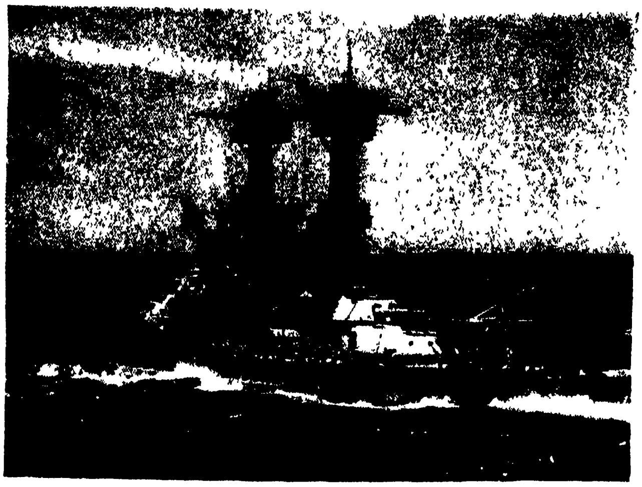
All illustrations Official U. S Navy Photographs

USS *Arkansas*, our oldest dreadnought

USS *Nevada* marked a new era in naval construction



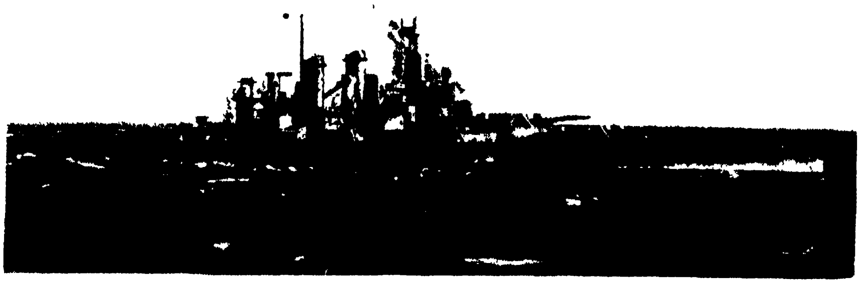
USS *Idaho* has been completely modernized



USS *Maryland* has not been modernized

addition of blisters, and the improving of the internal sub-division.

Between January and June, 1917, three fine ships, the *New Mexico*, *Idaho*, and *Mississippi*, were launched. As originally built they were slight improvements on the *Pennsylvania* design, but a few years ago they were so completely modernized that they may well be regarded almost as new ships. They are now the fastest and most stoutly protected of our older battleships and, everything considered, more formidable ships than the newer *California* and *Tennessee* and three *Marylands*, none of which has been modernized. Averaging just over 33,000 tons, the *New Mexicos* carry twelve 14-inch guns, have a 14-inch main armor belt, 18-inch protection for the big-gun turrets, minute internal sub-division below the water-line, and two decks (6-inch upper and 4-inch lower) over vital areas. Their 14-inch guns, of a more powerful model than in preceding ships, elevate to 30 degrees and have a maximum range of over 35,000 yards or some 20 miles.



USS *North Carolina* can just barely squeeze through Panama Canal locks

One of the most noteworthy features of these reconstructed ships is their relatively high speed of 22 to 23 knots, obtained by 40,000 horsepower Westinghouse geared turbine engines. The *New Mexico* has four White-Forster boilers and the other ships six of the Bureau Express type.

The *California* and *Tennessee*, launched in 1919, are slight improvements over the original *New Mexico* design. They were scheduled for modernization during 1940-41, but the Navy Department cancelled the work because of the threatening international situation—just a case of keeping the powder dry. Displacing over 32,000 tons, they have the same armament and vertical protection as the *New Mexicos*, but are not as stoutly armored against air attack, having decks only 3½ and 2½ inches thick.

These two ships are equipped with electric drive. Power for their four alternating current motors, one to each propeller shaft, is generated by turbines—General Electric in the *California* and Westinghouse in the *Tennessee*. Designed speed is 21 knots, which was reached on trials.

The *Maryland, Colorado,* and *West Virginia,* launched in 1920-21 and displacing from 31,500 to 32,500 tons, are almost identical to the *California* except for their main armaments of eight 16-inch guns and a 2-inch increase in the thickness of their waterline belts. The 16-inch guns, 45 calibers in length, elevate to 30 degrees and hurl a 2100-pound shell at a maximum range of over 33,000 yards.

THE *North Carolina* and *Washington*, launched in 1940 and costing nearly $70,000,000 each, are our newest and finest dreadnoughts. They are larger, faster, more powerfully armed, and more stoutly protected than any of our older ships and utterly different in general design and appearance. With their length of 750 feet, their beam of 108 feet, and their draught of 36 feet they can just barely squeeze through the Panama Canal locks. Their designed speed of 28 knots is obtained by geared turbine engines.

Their armament consists of nine 16-inch guns mounted in three heavily armored turrets, plus powerful secondary and anti-aircraft batteries. The 16-inch guns, of a new and very powerful model, have a range of about 40,000 yards. Two catapults and several planes are carried on the quarter-deck. These two ships are unique in having no portholes along the hull, ventilation and lighting being entirely artificial.

Work on four additional units of the *North Carolina* class is now being pushed as rapidly as possible. Three of them, the *South Dakota*, *Massachusetts*, and *Indiana*, begun in 1939, were launched last year and may be completed in time to join the fleet the latter part of this year. The fourth ship, the *Alabama*, launched this past February, will not be ready before next year. These ships will constitute a powerful reinforcement to our fleet and give us a definite superiority over the Imperial Navy. Our main battle fleet, composed of the six *North Carolinas* and the eight units of the *Maryland, California,* and *New Mexico* classes, should then be strong enough to take the offensive.

We Need More Physicists

Military Activity and Industrial Requirements Have Created an Unprecedented Demand

E. U. CONDON, Ph.D
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EVERYONE has heard of the science of physics, embracing our fundamental knowledge of the forms of energy—mechanics, acoustics, electricity, magnetism, heat, and radiation. And everyone realizes that the science is basic to every phase of our industrial activity. But how many of us know a physicist or have any conception of what he does?

The word "physicist" was seldom seen in newspapers until recently. Now these same news sources tell of a drastic shortage of professionally competent physicists, which shortage is leading to all sorts of emergency rush training programs. Asked by the editor of Scientific American to explain in what way physicists are essential to the war, I had, of course, to reply that this could be done only in the most general terms, since specific details of such war work are in the secret classification.

He replied that even so he felt that many people are quite uncertain about the distinction between physicist and engineer; that it ought to be possible to discuss their work in a way which would help the general understanding and especially would aid students in their choice of a career.

Until quite recently, the opportunities for physicists as such were almost entirely confined to college and university teaching. In the better universities this offers an attractive career, for with the work of teaching it combines facilities and a favorable environment in which to carry out research—to adventure in the unknown frontiers of knowledge with a genial band of like-minded explorers.

However, in the lesser colleges and universities the picture is not so attractive. In them the libraries and laboratories are usually inadequate for truly fundamental research, and the arrangements are such that the professor has so much teaching to do that he has very little energy left for original investigation.

Dr. Condon

In any case, the total number of positions available in university teaching is not great enough to support a very large number of physicists Fewer than 3000 physicists find employment in this way in the entire United States.

In recent years, however, a rapidly increasing number of physicists have found employment in industry, first and still mostly, in research laboratories, but also in engineering and production units as well. Now everybody thinks he knows the difference between a professor and an engineer. But when a physicist works with engineers in an industrial organization this question arises: What is the difference, if any, in their function, and on which kinds of work should one use the physicist and which the engineer?

The difference in them, by which we shall decide which label applies, is that the physicist elected physics as his major study, usually in a liberal arts college, whereas the engineer studied one of the recognized specialties, such as electrical engineering, in an engineering college. Another difference is that most physicists have continued university work beyond the bachelor's degree, gaining thereby some training in independent original research methods. On the other hand, it is much more usual for the engineer to leave the university on graduation from a four-year course and to go at once into industrial employment.

This difference in training manifests itself in a difference in approach to a given problem which is approximately described by saying that the engineer is a conservative and the physicist a radical about new scientific developments The engineer works best on the careful economic development of some applied science project whose general practicability has already been demonstrated. The physicist works best when trying to understand some newly-observed phenomenon that nobody as yet understands at all, or when trying some totally untried combination of ideas to get a new device of which

Some basic research must continue despite the war, for when peace comes we will have vast amounts of excess materials and the public demand for luxury items, long held in abeyance by military production, will come back

nobody is sure that it will be practical or even if it will work.

To any such broad generalization there are, of course, plenty of exceptions. Naturally, there are many scientifically radical engineers, just as there are some mighty conservative physicists. Here we are not trying to place a higher valuation on one type rather than the other: obviously both types are needed. As in other fields of endeavor, it must be noted that the conservatives and radicals often have difficulty understanding each other's view-point, even to the point of being sometimes mistrustful of each other.

But, anyway, it works out like this: The physicists are always busy looking into things in the physical world without much regard to their utility. In this way they are always aware of a lot of interesting phenomena which have not yet found, and may never find, any practical application, and they are trained in the art of digging up more such phenomena. The engineer, on the other hand, is busy with making important improvements and better application work in fields already established. Hence if a radically new device, or a radically new solution to an old problem, is needed, it is better to put a team of physicists on the job than a team of engineers. If nothing of the kind proposed has ever been done before, you are more likely to get it done (if it can be done at all) by physicists than by engineers

THE device you get from the physicists as a rule will not be very well designed either for reliability of operation or simplicity of manufacture. When the engineer sees it, he is apt to sniff contemptuously unless he is an unusually broad-minded fellow. But he should not be too intolerant, for the chances are, if it is a really new device, that he does not know the new principles which it utilizes or at least is not familiar enough with them to have thought of applying them. After the physicist has made such a laboratory model, it is up to the engineer to make an engineering design, in the course of which many detailed improvements will be made, before the device can be put into production.

With this picture in mind it ought to be clear why physicists are so very valuable in preparations for modern mechanized war. The Services want devices for locating enemy planes or submarines, or for exploding bombs under special circumstances, or for protection against magnetic mines, or for fire control purposes, and so on. If it is a device of a general kind which they already have, they can get improvements and production designs by turning the job over to a team of engineers. But if it is a device that is completely unknown—simply an idea for a device which would be tactically valuable if it worked—then a team of physicists is called for as being most likely to produce the device . . . if it can be done.

Our research preparedness activity on a large scale really dates from May, 1940, with the appointment of the National Defense Research Committee. By early autumn of 1940 the NDRC had decided on its main plan of action. Soon the best physicists of the country were organized into special teams and put to work applying the latest discoveries of the pure science laboratories to the solution of problems presented by modern warfare. It is fortunate indeed that the work was started this early—or rather most unfortunate that it was not started still earlier—since any new development of major importance calls for a tremendous amount of effort even before it is ready to be "engineered." Nevertheless, it can be said that several devices of great importance which have resulted from these efforts are already in production and many more may be expected soon.

Naturally, this "conversion" of the physicists has not been accomplished without completely upsetting their "business as usual." Up until recently their main concern had been the study of the great new field of atom-smashing

We will know more about metals after the war is over; research metallurgists are working as never before in their search for metal substitutes

or nuclear physics. Even a year ago nearly all of this fundamental research had come to a stop because of the demand for trained physicists to do war work. For example, our large four-million volt generator at the Westinghouse Research Laboratories has been shut down for months—not because this field of science is thoroughly explored or less significant, but simply because of the importance of the war job. The only cyclotrons operating now are those that are being used to prepare artificial radio-active materials for medical research

I first discovered Scientific American when I was about 14 years old, and reading it greatly influenced me in getting a clear notion that I wanted to do research in science Knowing that this magazine must be playing a similar part in the lives of boys today, I would like to close with a little advice to them.

Industry and science are being linked together by this war more closely than ever before. During the present war new advances in applied physics are being made which have brought about an urgent demand for young men with sound scientific training. Any boy who has a real aptitude for scientific studies cannot serve his country better than by devoting his best efforts to learning as thoroughly as he can and as quickly as he can and as much as he can about mathematics, physics, and chemistry. He should not scorn the "theoretical" fundamentals for hastily-gained superficial "practical" knowledge.

It is a great misfortune that many of the administrative officers of our public high schools have failed to appreciate the importance of sound training in fundamental mathematics and science. The quality of mathematical instruction in the high schools has sagged steadily in the past 20 years to such an extent that even the boy who gets an "A" grade in mathematics has a poor foundation on which to build his future work in science. No doubt the war will soon focus attention on this sorry state of affairs and reforms may result, but, in the meantime, boys who really want to help in this war should set themselves higher standards of mathematical attainment than most teachers demand.

Not only can the boy who has a real aptitude for science find a great opportunity to serve in the war, but with the steady advance in science-mindedness in all industry, it is safe to assume that the opportunities for scientific research in post-war industry will be much greater than ever before.

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DELAYED JUMP

Of Strip to Magnet

Demonstrates Atomic Change

A steel strip that, when placed under a powerful magnet, waits about a minute and a half before it jumps toward it, is the demonstration used by Dr Herbert H. Uhlig, of the General Electric Research Laboratory, to show a delayed change in the strip's atomic arrangement Exact knowledge of the nature of such changes is important in making magnetic materials for transformers and other electric equipment.

The strip used in the demonstration is a common type of stainless steel containing 18 percent chromium, 8 percent nickel, and the rest iron This metal, known as 18-8, is not ordinarily attracted by a magnet, because it usually contains a little nitrogen. The nitrogen seems to cause friction within the metal, which prevents the atoms from rearranging themselves to the phase in which a magnet causes attraction.

If, however, the same type of stainless steel is made nitrogen-free, it takes on other properties; the demonstration strip is a piece of such nitrogen-free metal. When the strip is heated to a temperature of 1100 degrees, Fahrenheit, it again loses its magnetic property. This property does not return until the strip is cooled down to the boiling point of water. Dr Uhlig, however, found that if the heated strip is suddenly cooled by quenching in ordinary tap water, and then placed under a magnet, it is not attracted, even though it is cooler than the temperature at which the change in the magnetic property of the metal should occur.

Time needed for atomic rearrangement is demonstrated magnetically

After about a minute and a half, however, it suddenly jumps to the magnet. Dr. Uhlig says that the atoms start rearranging themselves as soon as it is cooled, but it takes this time before a majority are shifted and at least a day before all reach a state of equilibrium

The change is one in the crystalline structure of the metal. At the high temperatures, when non-magnetic, it has the face-centered arrangement, with the atoms forming cubes piled like bricks. The low-temperature magnetic phase has them in the body-centered arrangement, with cubes interlocking, so an atom in the center of one forms the corner of adjacent cubes.

"From these experiments," said Dr. Uhlig, "we hope to learn more about the heat treatment of steels and the preparation of alloys with better mechanical properties and corrosion resistance."

EYES

Are Most Sensitive

Light Recorders

Proof that the eye is one of the most sensitive of all devices for recording light—far more sensitive than the best photographic emulsion or any other physical apparatus—was presented recently by Dr Selig Hecht in reporting the first experiments to measure precisely the smallest amount of light which the eye will record.

According to Dr Hecht, professor of biophysics at Columbia University, from five to fourteen quanta (a quantum is the smallest, basic, and indivisible unit of radiation, including light) will make an impression on the retina of the eye, thus leaving only a scant four smaller amounts of light which the eye is incapable of perceiving. He reported that for half a dozen observers, over a period of several months, the minimum energy necessary for vision was observed to be between 2 2 and 5 7 ten-billionths of an erg. This amount, he said, represents between 58 and 148 quanta of light emitted from the apparatus.

Most of this light is lost, however, through reflection by the cornea (outer shell) of the eye, absorption in the lens and other parts of the eye, and passage through the retina without absorption, Dr Hecht pointed out. Subtracting this lost light, the amount actually absorbed by the retina is five to fourteen quanta, he said, adding that since each quantum reacts with only a single molecule of the receiving substance of the retina, as few as five molecule changes would produce light impression

Have You Heterophoria?

Eye Exercises Using New Light-Polarizing Vectographs Can Improve Depth Perception

EVERETT WHITE MELSON

Don't be shocked if an optical test reveals some day that you have heterophoria. According to some of our best eye authorities, this condition exists in about 80 percent of the eyes examined. Ordinarily, a mild contraction of the muscles that move the eyeball always exists This is because the brain is attempting to fuse the images from each eye. It sends nervous impulses to the muscles to persuade them to pull a little more here or a little more there until the images appear on corresponding areas of each retina.

If there is a lack of balance in these eye muscles, one eye, or both, may be deviated so that the images appearing on the retinas cannot be fused and the binocular function of the eyes is lost. This function is most valuable, since it gives us depth perception, enables us to estimate distances, and provides us with contrasts and comparisons.

Heterophoria means that, due to some form of deviation of the eyes—one turning inward, outward, upward or downward—we cannot secure this binocular vision. We have to depend upon one image from one eye and thus lose the ability to judge distance and depth. Frequently this deviation is so obvious that anyone can see it, as in cross-eyes. More often, however, it is not apparent to an unskilled observer and the one who has it may be totally unconscious of it In many cases there is no pain or discomfort. In other cases it is quite distressing, particularly in close work. One of its worst features is that it may drift into such conditions as amblyopia exanopsia, in which the vision of one eye dims from lack of use This particular condition is generally agreed to be acquired and not congenital, and it can be cured

If you have ever observed a baby's eyes you may have noted that many of their movements are not coordinated. He uses them independently, largely because the brain has not been trained by experience to evaluate objects and to demand a fused image. He will reach for a bottle or a rattle and miss it by several inches When the brain begins to demand a fused image, one group of muscles becomes active in aligning the eyes for coördinate work while another set shapes the lenses to focus the objects These acts of convergence and accommodation are to a great extent acquired faculties. That they are acquired faculties, subject in a large measure to voluntary control, is evidenced by the fact that most people can converge or rotate the eyes at will

It is not enough that images shall be formed on corresponding areas of the retinas They must be symmetrically distributed around the fovea, a tiny depression in the center of the macula. The fovea and the macula have a great number of little cones, or photo receptors, which are extremely sensitive to both detail and color. Further, the two images must be similar in size, shape, and alignment in order to be capable of fusion. Since the two images are formed at a slightly different angle, due to the spacing of the eyes, they are slightly different—just enough different, in fact, to create the sense of depth when they are superimposed If they are not similar in size, shape, or location, a double image will result and the brain will be forced to suppress one image in order to see the other clearly.

Exercising at leisure

To orientate both eyes for the production of images on the macular areas, the six muscles that move the eye in its orbit must act in concert, some contracting and others relaxing. These are known as conjugate movements because these muscles are linked together by the nervous system. Likewise, the ciliary muscles, which are responsible for accommodation, are busy increasing or lowering the convexity of the lens so that objects can be sharply focused at varying distances.

Defects in the refractive system of the eye can be corrected by proper glasses, and imbalances in the muscles that move the eye are frequently corrected by the introduction of prisms to offset the deviation, but since the action of these muscles is subject to voluntary control, it is possible to provide them with a system of calisthenics to improve their coördination, thus improving the overlap in the retinal images and resulting in better depth perception.

It has been said that in some ways it is better to have one blind eye than two eyes in one of which vision is temporarily suspended, as is frequently the case in a deviation of one eye. The one-eyed person has two possible errors eliminated automatically—affections of symmetrical movement of the eyes, and image differences On the other hand, his sense of perspective can be only moderate since he must rely on the one good eye Some people, however, who have suffered the loss of vision in one eye at an early age have developed better judgment than their fellows who have defective binocular fusion, because the latter can be very dangerous in many occupations

In nearly all cases of faulty fusion faculty there will be either a tendency to suppress the more disturbing image of the two—resulting in a dimunition of vision—or to cultivate a squint in an effort to shift the more disturbing image out of view The latter may be unsightly, but at least the obvious defect may lead to early corrective efforts

Usually, in cases of heterophoria, whether in children or adults, the patient complains of difficulty in close work as the chief symptom If all refractive errors — irregularities in the transparent media of the eye—are corrected, a vast improvement can often be effected by proper exercises.

Occasionally, psychological cases are discovered, such as the one of a clerk, 30 years of age, doing close work and suffering from eyestrain, who was given a series of exercises to correct deviation He obtained a full range of fusion but his symptoms were no better. The fact was elicited that he hated his job and wanted to be an engineer but lacked the initiative to set about it. In this case, cure of the condition did not produce disappearance of the symp-

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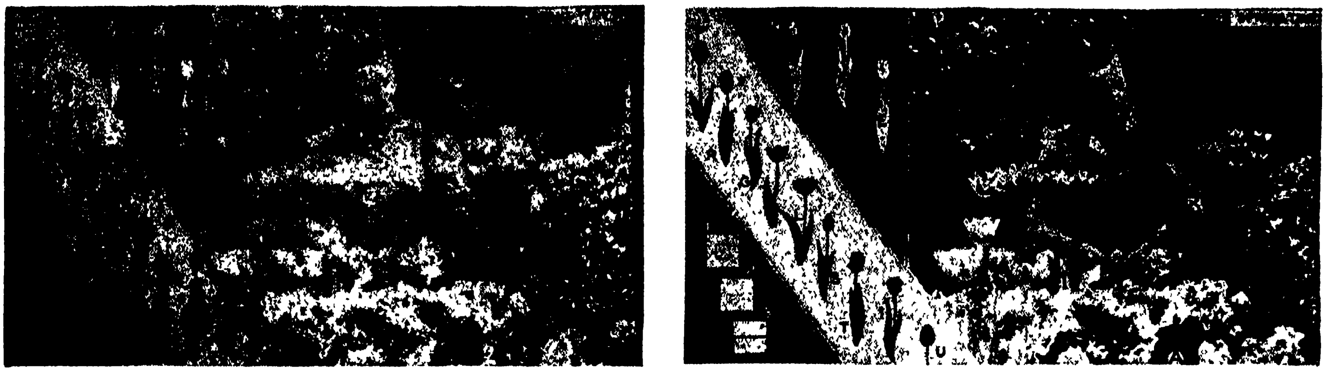
Specially prepared for Scientific American by Mr Melson, of Bausch & Lomb Optical Company



***Left:* How a vectograph transparency looks to the unaided eye and, *right*, when objects are fused**

toms, as might have been expected.

In another case, a woman lawyer, aged 28, complained of eyestrain when reading or driving a car. She refused to be bothered with exercises and was not seen again for ten years, when she reported no symptoms whatever. Examination showed that several diopters of deviation outward still existed, with no voluntary convergence. In the meantime, however, the woman had married and had children She was no longer worried and said she could read and drive with comfort. This is a case in which the symptoms disappeared with the patient's greater sense of security and life fulfillment, although the condition remained unchanged These cases are in the minority, however, and most of those who realize their deficiency are willing to make the necessary effort to improve their sight.

The branch of optical science which specializes in developing the coordination of the visual apparatus in muscular deficiencies is known as orthoptics. It involves the use of a number of training instruments, lenses, prisms, and sometimes light therapy. In general, the patient is required to visit the doctor's office to take the treatments, since many of the instruments are large and complex and the exercises must be supervised and progress measured.

In the effort to provide a method of home training, under the doctor's supervision, a new device has recently been introduced by the Bausch & Lomb Optical Company which utilizes a carefully graded set of photographs which are viewed through polaroid lenses to train the eyes and exercise the muscles both in convergence and accommodation.

This device, known as an ortho-fusor, consists of a group of pictures made by the vectograph process of Edwin H. Land It permits two complete and distinct pictures to occupy the same place at the same time, without distortion of tone, loss of detail, or interference with each other To the naked eye these pictures appear flat and fuzzy, but they are transformed into lifelike reproductions when viewed with polaroid glasses. As thin as paper, the pictures appear as deep as the original scenes themselves.

In conventional photography, pictures are rendered in terms of the density of distribution of the tiny silver particles in the emulsion. In the new process used in the ortho-fusor system, they are rendered in terms of variation in the polarizing characteristics of the transparent sheets on which the pictures are printed.

The two views necessary for recreating the sense of depth are taken with a camera equipped with two lenses as far apart as the eyes. The pictures are taken on regular film and developed in the ordinary way. It is in the process of making reliefs or transfer films from these negatives that the introduction of two pictures in the same film is worked out.

The two pictures are first made into relief images, in which the picture exists as variations in thickness of a gelatine surface, thicker for dark parts of the picture, thinner for light parts This relief film is used as a sponge to apply a chemical reagent to the final vectograph film.

This film has an invisible optical grain which runs in different directions on the two sides, as in a piece of plywood. When the relief films, soaked with reagent, are pressed against the vectograph film surfaces, the reagent combines with the vectograph film to form light-polarizing images; completely polarizing where the picture is to be dark and only slightly polarizing where the picture is to be light.

In the finished vectograph, two images are superposed, one on each side of the film. The picture thus appears blurred to the naked eye. The polaroid viewing glasses have the optical grain of each lens set in such a way that each develops the full contrast of one of the two images and makes the other invisible. Each eye sees the picture intended for it, as in normal vision.

The pictures comprise a variety of scenes. Boulder Dam, with its abutments, spillways, and generating station, makes a good subject. Others are an Indian squaw weaving a rug; a girl picking flowers; a famous Canadian cathedral. Around the borders of these pictures, cubes and other objects are arranged so that the eye follows them in a complete rotation while the head is held in a fixed position. Some of these objects are easily fused, others with greater difficulty.

The ortho-fusor is, of course, no substitute for glasses since the refractive media of the eye, such as the cornea and crystalline lens, must be corrected With any necessary optical corrections made, exercises to improve the coördination of the extrinsic muscles—those that move the eye in its socket—may be undertaken under the advice of an oculist or optometrist The small ortho-fusor kit, which contains the vectographs required for such exercises, may be carried in the pocket and used whenever a spare moment is available Thus the heterophoria sufferer may take his exercise frequently and at convenient times, hastening full return of true binocular vision and all its desirable features

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SULFANILAMIDE

Why the New Drug is "Unfair to Bacteria"

New research confirming earlier evidence that sulfanilamide attacks bacteria by literally starving the germs may provide a hopeful method of making drugs to order for specified germs.

Until recently, pharmacologists, the scientists who develop new drugs, have worked mainly on a hit-or-miss basis. Ehrlich, for example, tried 606 times before he hit on salvarsan, the specific drug for the organism of syphilis.

The new research is reported in *The Lancet*, British medical journal, by Dr

Sydney D. Rubbo and Dr. J. M. Gillespie, of the University of Melbourne, Australia. They found that p-aminobenzoic acid is needed by a certain type of bacteria for growth. This acid is similar in its chemical structure to sulfanilamide. When the sulfanilamide is present, the bacteria are tricked into using it instead of the necessary acid. Since sulfanilamide does not promote growth, despite the similarity in chemical structure to the acid, the bacteria cannot develop.

However, only one part by weight of the acid will offset the growth inhibitory qualities of 26,000 parts of the sulfanilamide. This is a possible explanation of why such large amounts of the drug are needed in treatment of bacterial infections.

ANTIBODIES

Just How Do They Perform Their Half-Mysterious Work?

The possibility of made-to-order or custom-built substances synthesized premeditatedly to curb definite germs, recently has become more prominent as a result of studies by Dr Linus Pauling of the California Institute of Technology.

He has been concerned with natural types of protective and life-saving substances found in the body—the so-called antibodies When a person is attacked by typhoid or diphtheria germs, to choose two familiar cases, it is the chemical products of these invaders which cause the disease symptoms. The body fights these injurious substances, which are of albumin or protein character, by preparing special proteins of its own to destroy the foreign ones.

The amazing thing about the antibodies is their specific action. They are essentially the same proteins normally present in the blood—the chemist has not yet been able to show any difference between them. Yet these antibody proteins in the blood of a diphtheria or typhoid patient have a tremendous ability to destroy poisons which the almost identical normal blood proteins totally lack.

Dr. Pauling has developed preliminary tests in an attempt to do what has never been done before—synthesize disease-curbing antibodies in the laboratory. The work is based on the scientist's important studies of protein structure.

Proteins are made up of huge molecules many tens of thousands of times heavier than hydrogen. The atoms composing these molecules are arranged roughly as a long chain with numerous short side branches, and the whole chain is coiled up on itself to form a compact, ultramicroscopic, roundish mass. Dr. Pauling believes that the differences between various antibodies and the blood proteins with which they are so nearly identical, is only in the way the chain has become folded on itself.

The California researcher uncoiled the molecules of a selected blood protein by using known substances that would do the job. Then to the solution he added another chemical. The straightened-out protein chains gradually folded up again, but this time they folded in a particular way, using the molecules of the newly added material as molds about which to coil. According to Dr Pauling, this process resembles what happens when normal body proteins are formed in blood contaminated by the molecules of diphtheria-germ poisons

The specific action of antibodies may be the result of blood protein molecules which mold themselves to various disease poisons and neutralize the harmful effects. That tremendously powerful antibodies will be produced in the laboratory and a host of diseases put to rout, seems a reasonable expectation from this particular piece of research.

STUTTERING

It Starts With a Linkage

Study of 15 child stutterers show a neurotic family background in the majority of the cases, Dr. J. Louise Despert, of the New York Hospital and Cornell University Medical College, reports, according to *Science Service*. Nervous mothers who are always worrying about whether the baby or small child eats enough are likely to have nervous children who stutter. These stuttering children frequently have other neurotic traits.

"This is of considerable importance," Dr Despert stated, "if one considers that the White House Conference of 1930 gave 1,300,000 as the number of stutterers in the United States and also that the majority of these cases are being treated by means of speech techniques which involve only the speaking organs and functions."

The stuttering results, Dr. Despert believes, from neurotic attention being focused on the mouth, usually with regard to the feeding situation in early years of life.

Children learn to talk at about the same time they learn to eat solid food and to feed themselves. They use the same structures to take in food and to form and pour out words. If their mother frightens them while they are trying to take in food, they are likely to be frightened also when trying to form and pour out words, and in consequence they may stutter and have difficulty in talking. The children themselves sometimes give the clue to this when they tell of their difficulty in attempting to bring out their newly formed words.

Treatment of these children consisted of general psychiatric treatment, with chewing-speaking games for the younger children or chewing-speaking exercises for the older children, in a few cases

HOW TO RELAX

Doctors Advise Other Doctors Who Can't Sleep

The following is from an editorial recently published in *The Journal of the American Medical Association.*

Cut down on the intensity of your thinking half an hour before retiring. (Play Chinese checkers, plan an excursion for the week end, write a letter to a friend)

Take plenty of time to get ready for bed (next morning's clothes, leisurely bath, and so on)

If you like to read in bed, choose nonfiction or a "hard" book. Force your mind to grapple with cumbersome facts, bore it into unconditional surrender to sleep

Transplant your mind from fears or hates to a field which has interest without excitement.

Make your mind hop from one idea to another Just as the mind loses consciousness and sleep comes, thoughts become disjointed and scattered.

To quiet the body, get rid of any pressure or pain (Lighten weight of covers, clothes.)

Tepid bath without a rubdown. (Get into bed a little damp and chilly. As the body becomes warmed, it becomes more and more comfortable If during the night one becomes sleepless, throw back covers until body becomes uncomfortably chilly. Then, when the covers are pulled up again, the body once more sinks into coziness)

Imitate the slow, deep, rhythmical breathing of sleep. (Helps regulate the circulation and may ease the mind and emotions; also tensions in the abdomen.)

Relax the muscles completely.

Get rested before trying to sleep. (Get into bed an hour or more before your regular time for retiring. Do so night after night to build up a reserve of rest and fall asleep without the old struggle.)

Astrono-Mexico

North American Astronomers Assist at Opening of Mexico's New National Observatory

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

Some time before the entrance of the United States into the War, the Mexican Government planned an Inter-American Congress on Astrophysics, to celebrate the inauguration of the National Astrophysical Observatory at Tonanzintla, and invited many astronomers and a few physicists and mathematicians from the United States and Canada to attend it. These lines are written on the return journey from one of the most conspicuously successful scientific meetings which the writer has ever attended, and an account of the new Observatory, of the general circumstances of the Congress, and of some of the papers which were presented, is very much in order.

The Mexican National Observatory at Tacubaya, founded more than 50 years ago, has long been known for its valuable contributions to positional astronomy, and especially for its work on a zone of the Astrographic Catalogue. Situated on a low hill but a few miles from the center of the City of Mexico, it has shared the fate of Greenwich, Paris, and other national observatories. The city, growing into a metropolis of more than a million people, has almost surrounded it, and its smoke and lights interfere with certain types of observation. A new national observatory has therefore been established at a site free from present, and probable future, disturbance of this sort. It is on a little hill overlooking the village of Tonanzintla, in the State of Puebla, about 50 miles southeast of the City of Mexico and ten miles west of the city of Puebla. For miles around stretches a nearly level, cultivated plain, some 7000 feet above the sea. Twenty miles to the westward the flawless, snow-crowned cone of Popocatepetl rises 10,000 feet above the plain and to the right is the older, rugged ridge of Ixtaccihuatl, almost as high, and snowier.

The writer has for years kept a record in memory of the amenities of observatory sites, and especially the views from them—and, of the many he has seen, Tonanzintla comes first. Its only rival is the outlook from Saanich Hill, at Victoria, on the semicircle of distant snow-mountains, from the Olympics to beyond the Canadian border—unless the works of man are included, when the near view of the Acropolis from the Observatory of Athens stands alone.

From the technical standpoint, Tonanzintla is an excellent site. Its altitude exceeds that of any observatory site in the United States except Flagstaff and the new Harvard coronagraph station at Climax, Colorado. The skies are free from contamination, the climate is favorable—with rains in the afternoon in the rainy summer season—and the latitude of approximately 20° gives it an enormous advantage. The Southern Cross rises well above the horizon, and the important galactic regions, Sagittarius and Carina, get high enough for satisfactory observation.

The principal instrument at present possessed by the Observatory is a Schmidt camera [see page 262.—Ed.] of 24 inches effective aperture, which in these clear skies will be a really powerful tool for the study of stellar distribution, space-absorption, and other galactic problems.

The Harvard Observatory has been in close association with the new Observatory of Tonanzintla and with its director, Dr. Erro, all through its organization and construction, and the installation of the Schmidt camera. In grateful recognition of this relation, the people of the village have named the street which runs up to the Observatory "Calle Annie J. Cannon," as a memorial to one of the pioneers in Harvard's astrophysical work.

The Observatory was formally inaugurated on February 17th by the President of the Mexican Republic, General Avila Camacho. The ceremony, held in the open air and favored by perfect weather, was impressive. A great crowd of people from the neighboring villages and the city of Puebla filled the slope of the hill. Behind them was a display of the massed flags (at least 200) of all American nations, from Canada to Chile, while in the distance rose the great mountains. The Governor of the State of Puebla, Dr. Bautista, made an excellent address, and the singing of the Mexican National Hymn, at the close, impressed all the delegates from north of the Rio Grande by its genuine fervor.

The Astrophysical Congress was opened, later in the day, in the hall of the University of Puebla, by President Camacho. The next morning the astronomers began three very busy days of scientific sessions at the University (whereof more later); but none of the delegates was busier than the President of the Republic, whose program for the first of these days included the inaugural ceremonies of seven institutions—schools, water-supplies, hospitals, and the like—all for the public welfare.

After returning to Mexico City, the delegates were taken to Tiripetio, site of the first school of higher studies in the Western Hemisphere. In the restored hall of this ancient school, honorary degrees were conferred by the University upon four of the delegates from the north, in a ceremony of equal simplicity and dignity. [The four were Doctors Shapley, Adams, Vallarta, and the author.—*Ed.*]

The scientific sessions, as befitted the international character of the Congress, were bilingual. Every communication, whether in English or Spanish, was accompanied either by the reading of an abstract in the other language, or by a running translation at intervals of a minute or two. As always happens in such international meetings, it was not the "Norte-Americanos" who were the interpreters. A few of us were able to present our results in passable Spanish; but for fluent and accurate translation we had to depend upon our hosts.

To take a typed abstract in one language and read it off freely in another is hard enough; but several of our Mexican colleagues performed the far harder task of translating talks in English—not read from manuscript, and often including technical descriptions of slides and tables—with completeness, accuracy, and more eloquence than the original speaker could boast.

Almost 40 scientific papers were communicated to the Congress.

Adams, discussing interstellar lines, reported that the sharp lines so far observed in the spectra of distant stars have now all been accounted for. There are two lines of evidence that the interstellar gas which absorbs them is not uniformly distributed In the spectra of some stars, the interstellar lines of the compounds CH, CH^+, and CN are strong, compared with those of the metals; in others much weaker—while the metals are strong—showing that the interstellar gas is far from uniform in composition. Advantage was taken of this in the recent discovery of faint lines of interstellar iron, in the spectra of stars in which the lines of other more abundant atoms appear most strongly Moreover, photographs with very high dispersion show that the H and K lines of ionized calcium are not merely double—as was discovered by Beals, in Canada, some years ago—but that in some cases there are three or even four components of different intensities. The only reasonable explanation appears to be that there are three or four different clouds of gas in different parts of the line between us and these stars, each containing calcium atoms, but moving with different velocities which sometimes disagree by as much as 20 kilometers per second.

Interstellar matter must be very patchy in distribution This is also indicated by a report by Stebbins upon new photoelectric measures of star colors The apparatus is now so delicate that it has been possible, with appropriate color-filters, to measure the brightness of many stars in six spectral regions, ranging from λ3500 in the ultra-violet to λ10,000 in the infra-red Very accurate determinations of star-colors may thus be made. The well known "space-reddening" of distant stars, above and beyond the color normal for their spectral type, may thus be precisely measured The properties of the interstellar dust which produces this effect appear to be uniform, as regards the relative effects for different wavelengths, but the actual amount of absorption for stars at the same distance is very different, showing that the distribution of dust, as well as gas, is highly irregular.

An important, and previously unrecognized, function of this interstellar matter was discussed by Whipple, who showed — following Spitzer — that a cloud of such dusty gas, absorbing much of the starlight which passed through it, would be compressed by the pressure of starlight from the outside, as well as drawn together by its own gravitation, and might ultimately condense into bodies whose mass—depending on the density and other characteristics of the cloud—might range from that of an asteroid to that of a large star.

This may solve a very puzzling problem which the writer—discussing the present state of the problem of stellar evolution—had posed without answering. There is abundant evidence that the Earth, and our existing universe of stars and galaxies, is some two billions of years old, or a little more. It is well known that the stars of greatest mass and luminosity are spending their capital of available energy at such a rate that the greatest known source—the transmutation of hydrogen into helium—would keep them going for only a hundred thousand years or so. Whipple's work (corroborated by some of Spitzer's) opens the possibility that these stars may really be younger in years than the Sun. They may have existed, for most of the history of the universe, as diffuse, nonluminous masses of dust and gas, finally condensing and beginning their spendthrift careers as stars during the last few percent of the Earth's history

Stars of the Sun's mass, however, live their lives slowly. Bethe showed, a couple of years ago, that such a star should become slightly larger in diameter, considerably hotter on the surface, and very much brighter, as its hydrogen became exhausted. In these later stages, such a star would have a spectrum of class B, but be very much smaller and less luminous, as well as less massive, than the general run of stars of this type Few, if any, such stars have been observed It has usually been supposed that this was because the stars passed through these stages so swiftly that there were few of them to be found there at any given time, but the writer pointed out that these stars, being bright, could be seen at large distances, which more than makes up for the time-effect The fact that we do not find such stars (so far as our present search has gone) indicates that stars like the Sun have not had time to reach these late evolutionary stages since the present state of the Galaxy began. Incidentally, from a combination of the data of various investigators, it was shown that the known properties of the Sun can be well explained if its interior contains 51 percent by weight of hydrogen, 42 percent of helium, leaving 7 percent for all the heavier atoms—of which one tenth is carbon and nitrogen. These are rough values—adjusted to add up to 100 percent. More accurate studies—which may be hoped for in a few years—should lead to a better determination.

Several other papers dealt with the distribution and motions of stars in the Galaxy. Baker, from star-counts in Cassiopeia and Aquila, and Bok and his associates at Harvard, from similar studies of regions in Monoceros and Centaurus, find a general tendency for the star-density (that is, the number of stars in a given large volume of space) to fall off with increasing distance from the Sun—especially for parts of the Milky Way remote from its center in Sagittarius, and for stars of spectral classes near F. This is after allowance has been made for the effects of certain absorbing dust-clouds at distances of 500 parsecs and more. Mayall, from the radial velocities of 50 globular clusters—many more than have previously been observed—finds that the motion of the Sun, relative to the mean of the clusters, is in the plane of the Milky Way, at right angles to the galactic center, and at the rate of 170 kilometers a second. The first two results were to be anticipated: but the velocity is only about 60 percent of the 300 kilometers a second which has generally been adopted as representing the rotation of the Galaxy A large number of clusters south of declination −40° have not yet been observed, and cannot be until suitable equipment is put into service at some observatory in the southern hemisphere. Their inclusion may bring up the calculated velocity considerably If it does not, we will then have to choose between two alternatives. Either the Galaxy is considerably smaller than we suppose at present, or else the system of globular clusters is rotating in the same general direction as the Galaxy, but more slowly

To pass from far to near, two papers dealt with astronomical phenomena in the Earth's atmosphere. Elvey, from observations at the McDonald Observatory upon the light of the night sky, finds that certain lines—notably those of sodium and the red forbidden lines of oxygen—increase greatly in brightness as the first direct rays of the Sun strike the uppermost layers of the air at dawn, and fade out rapidly after they leave them at twilight. Many other radiations, such as the familiar green line of oxygen, change little at this time, but show irregular variations from night to night. These require further study, but it is already clear that they are greater on nights when the Earth's magnetism shows disturbances.

It was a first-rate conference; and every one of the delegates will agree with the writer's expression of thanks to the Mexican Government, and to the Director and staff of the Tonanzintla Observatory, for the admirable planning and emphatic success of the Congress, and for the great and unfailing hospitality which all its members have enjoyed.

—On the Mexican National Railway, February 27, 1942.

Why are We Short of Aluminum?

Huge Quantities of Electricity are Needed to Reduce this Common Metal from its Ore

HENRY W. ROBERTS

American troops go into Surinam and Dutch Guinea to protect vital bauxite ore deposits, to assure us of enough aluminum to win the War . .

Aluminum is *the* vital war metal. We need it for our battle planes; we also need it for a thousand other war uses—from canteens to battleships.

Aluminum is plentiful One twelfth of the earth's substance is aluminum There is nothing more common in nature. And yet we are now short of aluminum Despite last year's record production, we are still short of aluminum for our defense needs, have none to spare for our civilian needs. It takes thousands of pounds of aluminum to build a bomber, a good deal less to build a fighter plane

Three years ago Germany produced less aluminum than either the United States or Great Britain A year ago the United States and Great Britain, together, produced less aluminum than Germany alone Today, aluminum production by the United Nations is running neck and neck with the Axis countries

What do we need to outstrip the Axis in the production of aluminum? Where is the choke-point that has so dangerously slowed up our production of this vital war metal?

Aluminum is one of America's contributions to the world's industries. Discovered in Denmark, in 1825, aluminum remained a scientific curiosity until 1886 when a young American, 22-year old Charles Martin Hall, succeeded in reducing aluminum oxide to metallic aluminum by a new process which made possible commercial production of this metal.

The first aluminum which Hall produced cost eight dollars a pound. Three years later, in 1889, the cost was down to five dollars a pound. Today, aluminum costs about 15 cents a pound

In 1934, when Germany's rearmament program had already begun rolling, the entire American aluminum industry—which then meant the Aluminum Company of America—produced only 74,000,000 pounds of virgin metal To this was added 42,000,000 pounds of secondary metal (scrap); another 18,000,000 pounds was imported. That gave us 134,000,000 pounds in all, just barely sufficient for our normal needs during the normal years of peace.

Surface mining of aluminum ore—bauxite

By 1939, with the war in Europe obviously imminent, our production rose to 327,090,000 pounds. In 1940, with war at hand, we produced over 400,000,000 pounds of aluminum.

Last year, 1941, with war staring us in the face, we were still hopelessly short of aluminum. Including all the scrap that we could collect, our total aluminum production still fell short of the goal which was set for that year

This year, 1942, with the aluminum industry being rapidly expanded, we should be able to produce considerably more of the virgin metal. Several million pounds may come in to us from Canada, and perhaps a like amount may be added through drives for scrap aluminum. This would give us barely enough for our 1942 military needs, still nothing for civilian needs.

What, then, is holding back unlimited production of aluminum, the most common metal on earth?

The principal source of aluminum is bauxite, a red-yellow ore rich in aluminum hydroxide. Bauxite occurs in nature in large mass deposits, usually found close to the surface of the earth There are vast deposits of bauxite all over the world, principally in France Hungary, Italy, Jugoslavia, Greece Russia, British Guiana, Surinam, Netherland Indies, and the United States of America. The world's richest bauxite mines are in South America, in Dutch Guiana and Surinam. Four pounds of this bauxite make one pound of aluminum.

Control of these rich South American mines is vested largely in the Aluminum Company of America, which conducts the mining operations and maintains a large fleet of cargo ships to transport the bauxite from the ports of Moengo and Paranam, at the mouths of the Cottica and Surinam Rivers, to American and Canadian ports More than two-thirds of all the aluminum produced in the United States is made from this South American bauxite.

One of the more serious obstacles to increasing our aluminum production under wartime conditions is the current lack of sufficient shipping which can be diverted to the transportation of additional bauxite from South America to this country.

Meanwhile, tremendous deposits of low-grade bauxite (and of another aluminum ore, alunite) were recently discovered in the United States, in our South and Southwest, but principally in Arkansas. About half of the bauxite mined in the United States goes into the production of aluminum, the other half being consumed in the production of artificial abrasives, chemicals, refractories, and insulating materials.

These low-grade Arkansas bauxite

deposits are now being commercially exploited, principally by the recently organized aluminum division of Reynolds Metals Company. Despite its much lower aluminum content, our Arkansas bauxite competes successfully with the richer ores from South America, mainly because the Arkansas bauxite need not be transported by sea.

Unlike most metals, aluminum cannot be reduced directly from its ore, the bauxite. First, the impurities in the ore must be separated from the aluminum hydroxide; this is a chemical process Next, the aluminum hydroxide must be calcined to produce pure aluminum oxide, or alumina Last, the alumina must be reduced to metallic aluminum The entire process is rather complex, and quite expensive, requiring large investments in plant and machinery, and consuming prodigious quantities of electric power.

Casting aluminum

The first step in the processing of bauxite into aluminum takes place at the mines. The raw ore taken out of the ground is hauled to a nearby mill where it is crushed, screened, and washed. The lumps of ore, now less than two inches in the greatest dimension, are carried into classifiers, where the washing process is repeated several times to remove as much clay as possible Clay contains silicon oxide, or silica, an undesirable impurity in the processing of aluminum. After the washing process has been completed, the ore is thoroughly drained, dried in long rotating kilns, and is then ready for shipment to the alumina reducing plants.

There are now only three alumina plants in the United States: those of the Aluminum Company of America, in Illinois and Alabama, and the new plant of Reynolds Metals Company in Alabama, completed late in 1941.

Several processes of reducing bauxite to alumina are known; the one commonly used in this country is the Bayer process, developed about 50 years ago by Karl Josef Bayer, a German chemist. The crushed, washed, and dried bauxite from the mines is further crushed, and finally ground to powder. The powdered bauxite is then mixed with a hot caustic soda solution, and the mixture of soda and bauxite pumped into large pressure tanks, called "digesters." The caustic soda dissolves aluminum hydroxide out of the bauxite, and the liquid becomes a solution of sodium aluminate. The impurities in the ore do not dissolve, and are removed from the solution by filtering.

The filtered sodium aluminate solution is then fed into huge precipitation tanks, where it is cooled. As the solution cools, aluminum hydroxide settles out of the solution in the form of white crystals. The caustic soda solution is then pumped off, to be used again, and the white crystals of aluminum hydroxide are dried, and then calcined in special kilns The calcining process removes the water chemically combined with the crystals, leaving a white powdery mass of aluminum oxide This white powdery mass is called *alumina.* For each pound of alumina, two pounds of high-grade bauxite were required.

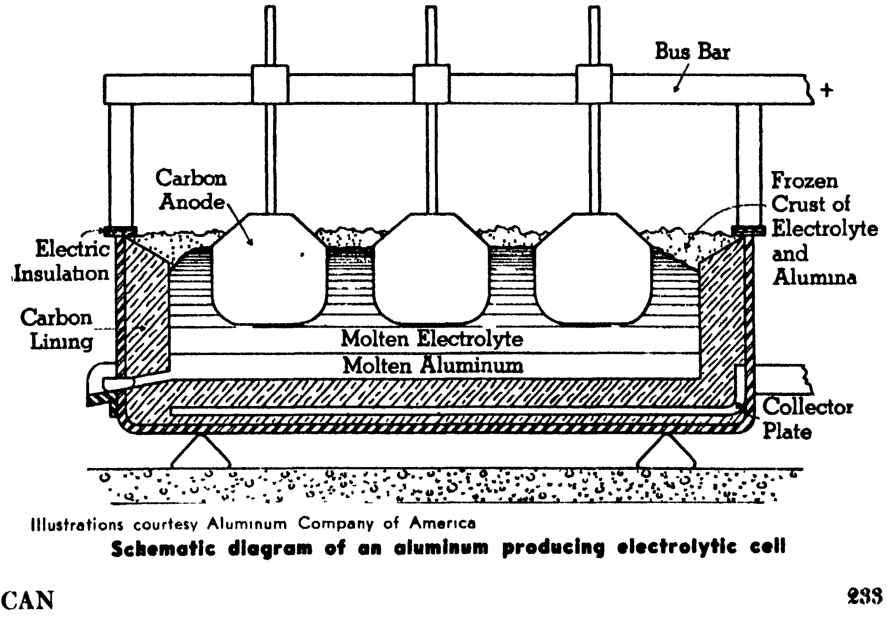
The next step is the reduction of alumina to aluminum. The process universally used is the Hall-Héroult electrolytic process, named after the American, Charles Martin Hall, and the Frenchman, Paul Louis Toussaint Héroult, who developed this process, independently of each other, in the last century. Because of the tremendous electric power requirements of the process, the aluminum reduction works are usually located near large hydroelectric plants where electricity is invariably both cheap and plentiful.

There are at present only five aluminum reduction plants in the United States—all of them belonging to Aluminum Company of America—distributed through New York, North Carolina, Tennessee, and Washington. A sixth plant, owned by Reynolds Metals Company, is nearing completion in Alabama, a seventh will be located in Washington.

The principal equipment of the aluminum reduction works is the electrolytic furnace, or cell. Each cell is a rectangular steel "bathtub," its walls lined with carbon which serves as the cathode or negative pole of the cell. The cell is filled with a rare white mineral, cryolite, or "ice stone," which is fused by the electric current into a molten mass. This molten cryolite is the electrolyte of the cell. Immersed in the cryolite bath are several carbon anodes, suspended from overhead busbars; these serve as the positive pole of the cell.

Molten cryolite is the magic substance which dissolves alumina (aluminum oxide) The electric current passing through the molten cryolite bath decomposes the dissolved aluminum oxide into its component parts: aluminum and oxygen. The oxygen is liberated at the anodes and escapes through the crust at the top of the bath. Aluminum is deposited on the bottom and the walls of the cells (the cathode), and forms a molten layer of metal at the bottom of the bath, whence it can be drained off into ladles and cast into pigs.

The normal capacity of each cell is 250 pounds of aluminum, sufficient to cast five 50-pound pigs. Into the making of each pound of aluminum go four pounds of bauxite, three-quarters of a pound of carbon electrode, and 12



Illustrations courtesy Aluminum Company of America

Schematic diagram of an aluminum producing electrolytic cell

kilowatt-hours of electric energy.

The aluminum reduction process is a continuous operation. As the molten aluminum is drained off, more alumina is added to the cryolite bath. The cryolite itself is not affected by the process, and is used over and over again.

It is fortunate that cryolite is not affected by the process: the only commercial cryolite mine in the world is at Ivigtut, in Greenland. Greenland, you will recall, is now occupied by American troops. It is probable that more cryolite may be found in Iceland. We have troops in Iceland. But there is no connection between United States troops and cryolite. We have all the cryolite that we are likely to need; we could also make synthetic cryolite, fully as good as the real thing.

The pig aluminum still has to undergo several transformations before it becomes a battle-plane. The first step is to melt pig aluminum into ingots; this removes residual impurities and gives the bulk aluminum a more easily workable shape.

Sometimes an aluminum alloy and not pure aluminum is required; then the alloying is done at this stage. One of the best known and most frequently used alloys is duralumin. This remarkable alloy, after heat treatment, is as strong as mild steel, but weighs only one third as much. Duralumin is the alloy principally used in aircraft construction.

To become technical for a moment, aluminum has a specific gravity of 2.70: one fourth to one third of other common commercial metals. The metal is non-toxic, is resistant to corrosion, and has high thermal and electrical conductivities. What is more important, aluminum is a most versatile metal; it may be cast, rolled into bar and rod stock, drawn into wire, or rolled into plate, sheet, or foil. It may be drawn into tubing, or into extrusion shapes; it may be forged or pressed, or made into screw-machine products, rivets, or nails, or made into powder. There is no other metal which can serve industry in as many shapes and forms as can aluminum and its alloys.

Now, just where is the choke-point in our aluminum production?

There is no shortage of bauxite. We have, here and in South America, more than enough bauxite to make all the aluminum that we are going to need.

Is there a shortage of labor? Emphatically "No"! No skilled labor is required for the mining of bauxite. The processing of bauxite into aluminum is, essentially, an automatic operation, requiring very little labor.

There is no patent monopoly. All the important patents on the processing of aluminum expired long ago. Nor is there a monopoly in our aluminum industry; at least, the courts say so. In addition to Aluminum Company of America, the metal is being processed by Reynolds Metals Company, and Bohn Aluminum Company is expected to be soon added to the roster.

Admittedly, our aluminum plant facilities are still too few: there are as yet only three alumina plants, and only five aluminum reduction plants. But the few million dollars necessary to build additional plants will never present an obstacle to increased aluminum production so urgently needed.

The real choke-point of aluminum production is electric power. Remember, 12 kilowatt-hours of electric energy are required to make one pound of aluminum. Last year, the aluminum industry needed, *each day*, enough electric energy to supply all needs of a modern city with a population of 25,000 persons for a whole year!

We do not have enough electric power. Already the towns and villages in the vicinity of aluminum reduction plants are feeling the pinch, will feel it more as time goes on. The great hydro-electric plants are all working at full capacity. Even the new Bonneville Dam project, barely completed, already has its entire output earmarked.

This choke-point is now being broken with the aid of our Government. Not so long ago Jesse H. Jones, Federal Loan Administrator, announced that the Defense Plant Corporation will provide $52,000,000 for the construction and operation of four aluminum plants by the Aluminum Company of America. With these additional plants American aluminum production should reach a much higher figure annually. Additional negotiations are now in progress with the Reynolds Metals Company and other aluminum producers.

The four new plants will be comprised of one alumina processing plant in Arkansas, and three aluminum reduction plants: one located in New York; another in a western state; and a third in Arkansas.

The ownership of the four new plants will remain with the Government. The Aluminum Company of America will merely operate them under a five-year lease, paying the Defense Plant Corporation 85 percent of net operational costs. The agreement provides that the new government plants must be operated at the same relative capacity as those now owned by the Aluminum Company of America.

With care and vigilance, we shall have enough aluminum—enough to win the War!

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INSULATION

Board Made of Glass Replaces Cork

With importations of cork from Spain and Portugal becoming increasingly hazardous and uncertain, and with existing supplies in this country under rigid priorities, a new insulating board, said by experts to possess all of the insulating properties of cork, and to be superior in some qualifications, holds considerable interest. This new board, produced by Owens-Corning Fiberglas Corporation for low-temperature and roof-insulation applications, marks a development of unusual importance in that it will tend to release the United States from dependence upon cork in meeting the tremendous war-created demand for cold-storage refrigeration of perishable food supplies and industrial materials.

Known as AE Board, the new insulating material is made of pure glass fibers, compressed to a density of six pounds to the cubic foot, treated with a thermosetting binder, and completely enclosed in a sheath of asphalt that has a high melting point. Its heat conductivity is 0.265 B.T.U. per square foot per hour, per degree Fahrenheit, per inch thickness, at a mean temperature of 60 degrees, Fahrenheit. This compares with a figure of 0.27 for cork. Since the new insulating board is made of materials which are found in adequate quantities within the United States, a supply sufficient to meet all essential needs is assured.

It is estimated that the 1942 need for insulating materials for low-temperature installations will be in excess of 200,000,000 board feet. The feeding of the armed forces, the tremendous shifts in the industrial population, and the enormous expansion of industrial plants, all augment the normal requirements for cold-storage refrigeration. Adequate refrigeration is needed in the preparation, storage, and transportation of perishable foods and is an essential element in the processing of quick-frozen foods which today play an important role in the nation's diet. The cold processing of industrial materials, including many oils, chemicals, and rayon, requires the control of temperatures within a narrow range, necessitating adequate low-temperature insulation.

The value of roof insulation for industrial buildings has been firmly established. Insulation of the roof cuts fuel and air-conditioning costs. It also tends to prevent condensation on the underside of the deck, and consequent damage which may be caused by roof drip—an increasing problem in air-conditioned structures. Frequently the installation of adequate insulation in the roof makes it possible to reduce the size and cost of heating and air conditioning equipment. It is estimated that 800,000,000 square feet of roof insulation will be installed on new industrial buildings between now and the end of 1943.

The Fiberglas board is made in the "American Standard" size for refrigeration insulation—12 inches by 36 inches—and in thicknesses of one, one and a half, and two inches. The insulation has high resiliency, and shows almost complete recovery in five minutes after loading to 1728 pounds per square foot—a load far above the normal encountered in refrigerated spaces or roof-deck service.

All special-size pieces can be made up on the job by cutting the board to size, and sealing the cut edges with hot asphalt. The material can be sawed with an ordinary saw if the blade is frequently lubricated with kerosene to prevent the asphalt coating from gumming the teeth. For curved surfaces of large radii, the board can be slotted on one face and bent to fit the required curve.

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PLYWOOD—Soybean adhesives glue up to 2.3 billion square feet of plywood yearly—enough to make a four-foot "board-walk" around the equator four times, with several thousand feet of the strip left over.

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RESEARCH

Organization Plans For the Future

ANNOUNCEMENT was recently made by the Auto-Ordnance Corporation, manufacturers of the Thompson Sub-Machine Gun, of the formation of a Department of Research and Development at Stamford, Connecticut, for the purpose of expediting America's war effort, continuing improvements in its own manufacturing, and the development of post-war products to cushion industrial readjustment following all-out military production.

This department includes Don D. Myers, well-known designing and research engineer of Toledo; Dr. H. H. Sheldon, formerly Professor of Physics at New York University and a contributor to Scientific American, and Mr. Albert Thomas, well-known inventor and designing engineer who was recently associated with the Glenn Martin Company

Anode plate being lowered into the steel tank of an Ignitron, an electrical rectifier that is playing a large part in present-day magnesium production

MAGNESIUM

Production from the Sea Aided by New Device

A BARREL-SIZED steel tank that sifts electrical charges through a pool of mercury is speeding production of two vital war metals by helping to "rescue" magnesium from the ocean and to extract aluminum from bauxite

This "electrical alchemist"—known as the Ignitron—10 years ago was only a laboratory curiosity, but now is an important industrial tool for producing the lightweight metals urgently needed for military aircraft

The Ignitron was developed by Dr Joseph Slepian, associate director of the Westinghouse Research Laboratories, in co-operation with engineers L. R. Ludwig and J. H. Cox. The device expedites war production by changing alternating current electricity into the direct current required in electro-chemical processes used by magnesium and aluminum plants.

Half a million kilowatts of direct current electricity—enough power to drive 10,000 street cars—was added in 1941 to the power supply of aluminum plants in the United States and Canada by the installation of Ignitrons. Millions of pounds of magnesium are now being extracted from pumped sea water when magnesium hydrate is precipitated from the water, converted into magnesium chloride and reduced to magnesium by an electrolyzing process employing Ignitrons About four and a half million tons of this important metal can be "rescued" from a cubic mile of sea water, according to statements by metallurgists

Suspended in the Ignitron's tank is a graphite electrode connected to the alternating current supply. In the bottom of the tank is a shallow pool of mercury. Fastened above the pool is an inch-long pointed piece of boron carbide the thickness of a pencil This dips into the mercury and is the spark plug or igniter that makes the Ignitron work.

In operation, positive electricity from the alternating current power line is conducted to the graphite electrode in the top of the Ignitron tank and also to the igniter The instant this positive electricity reaches the igniter it forms a spark or "cathode spot" on the mercury pool and permits the power current to flow. When the current changes to the negative phase, the rectifying property of the mercury vapor prevents any discharge from passing in the reverse direction.

With 60-cycle current, this phenomenon is repeated 60 times a second, producing the required one-directional flow of current from the Ignitron to the industrial process for which such current is needed.

INDUSTRIAL TRENDS

NUTS, BEANS, SEEDS . . . AND OIL

Coconut palms, swaying gracefully in the warm, scented breezes of the South Pacific, are an important part of the imaged landscape of song and fiction writer; of far greater importance are they to a wide range of industries which, today, are in somewhat of a dither as to what to do about those products of the coconut which no longer reach our shores from far-off lands of fabled romance

Outstanding product of the coconut palm is the oil yielded by the nuts, which, together with other vegetable oils from the Philippines and points west, enters such differing industries in the United States as those concerned with the production of foods, paints, leather, soap, lubricants, metals, and explosives.

Here is what the Department of Commerce has to say about the situation in oils and fats, the twins that are usually linked together and which include those of both vegetable and animal origin: "We normally produce domestically such food fats as we need and export, but domestic production is a third short of supplying all the fats and oils we need for soap, slightly more than a third short of those necessary industrially, and half short of our paint and varnish needs Curtailment of our Far Eastern imports will directly affect the soap and glycerine, tin-plate, and textile industries, and will necessitate changes in composition among our manufactured fats and oils products."

Agriculture in the United States is being stepped up in certain branches to contribute its share in making up these shortages. For example, during 1942-43, production of peanut oil will be aimed at a goal 600 million pounds in excess of that produced during the 1941-42 season; for soybeans the figure will be 350 million pounds more, and for flaxseed some 100 million pounds These increases will go a long way toward filling in the gaps left by coconut and other exotic oils in certain applications, but there is something about the coconut that makes its products particularly desirable. The oil gives quick-lathering properties to soap, in the manufacture of which it finds its widest use The food industry consumes large quantities of coconut oil in the production of margarine, salad oils, shortenings, and so on From it is obtained glycerine, essential to munitions manufacture, and this harks back to the soap industry in which glycerine is a major by-product that, today, is overshadowing in importance the main product

But oil is not the only thing that the coconut yields; its shell, for example, is made into activated carbon which has the peculiar property of adsorbing gases and odors and finds application in the chemical industry as a decolorizing and clarifying agent. Greatest demand of the moment on activated carbon is, of course, in the manufacture of gas masks.

Before discussing the general trend that is rapidly developing as a result of the current shortage in coconuts, it is interesting to note a specific case where research has already licked the problem in one typical American way In the leather industry coconut oil has long been used for certain types of tanning operations, in which its non-oxidizing qualities are particularly desirable Faced with the need for finding a suitable substitute, one oil processing company has developed from domestic vegetable products an oil for use on leather that is said to be comparable in every way with coconut oil. So satisfactory is it, in fact, that interested parties have gone on record as saying that it is doubtful whether coconut oil will be able to re-establish itself in this particular industry after hostilities cease and supplies are once more available.

It cannot be recorded, however, that the problem of coconut oil can be solved so readily in every case. But there is a silver lining which, properly developed, can undoubtedly eliminate completely the dark cloud, or at least reduce it to unimportant dimensions. South America holds the answer. In that vast continent are a number of natural nuts which yield oils that are chemically equivalent to coconut oil. They are available in large quantities and, at least in some cases, have shells from which can be made activated carbon for the uses mentioned above.

There must be a joker somewhere. Otherwise, why would these sources of vegetable oils have remained undeveloped for so long, while the coconut held the center of the stage? There are several answers. All of those South American nuts which yield sufficient quantities of oil to warrant commercialization have hulls that are hard to crack. Crushing the hulls bruises or crushes the kernels, which contain the oil, thus spoiling the nut for further processing. There have been small quantities of oil from the babassu and cohune nuts placed on the market by South American companies, obtained through the long and tedious process of cracking the hard shells by hand and then pressing the oil from the kernels But since hand cracking proceeds at a rate of about 180 nuts per hour, the oil output is exceedingly limited

A further obstacle, but one that is not insurmountable, is the reluctance on the part of many South American countries to permit export of uncracked nuts of certain varieties Reason, of course, is to keep the cracking industry at home for the benefit of native labor.

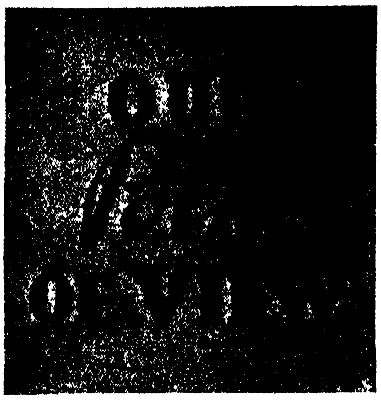
Yankee ingenuity has gone to work on mechanical crackers for these tough nuts, with a considerable degree of success. Several crackers have been devised that will crack the hulls at a high rate of speed, leaving the precious kernel intact With these available, and with increasing co-operation between the United States and its southern neighbors, there is every reason to believe that South American nuts of a variety of species will soon aid greatly in replacing the coconut

Here, then, is a definite trend in the vegetable oil industry which will be carefully watched by all other industries that have heretofore been dependent on oils imported from the Far East And with one eye on the development of South American nut oils, the other eye will be kept on the field of synthetics at home With such an opportunity opened by Mars, it is not hard to believe that the American chemist will soon pull from the bag a whole family of synthetics which will fit neatly into the industrial needs of the moment.

SYNTHETIC RUBBER . . . AND OIL

The petroleum industry which, directly or indirectly, supplies many of the sinews of peace and war, is going to play a much larger part in the synthetic-rubber picture than most people are aware of Approximately three quarters of the production of this material at the end of 1941 was being made from petroleum-base raw materials If the present trend continues, and it is indicated by government officials that it will, most, if not all, of the synthetic rubber being produced by 1943 will be made from products of the petroleum industry.

—The Editors



AN OPEN LETTER TO DONALD M. NELSON

Dear Mr. Nelson.

You are being widely quoted in the newspapers on the subject of dangerous complacency on the part of the American public in general and of American industry in particular. While I agree thoroughly with you that such complacency could, at the very least, prolong the length of the war and, at the worst, result in ultimate defeat of our nation, I feel that many of the charges of complacency are incorrectly aimed Or, I might better say that some of them should be directed inward rather than outward

My thoughts in this important phase of our all-out war effort are prompted by intimate contact with American industry. They are based on observation of progress and on conversations and correspondence with key men in a broad range of productive endeavor. Because I feel that these thoughts will be valuable to you in your work, I am taking this means of bringing them to your attention.

We—you and I and every other loyal American citizen - want to see this war prosecuted to a rapid and successful end We all fully realize that the means lies in the hands of American industry. But such is the nature of present operations that American industry is not permitted, in many cases, to exercise its ability to produce tanks and planes, ships and guns with the same efficiency and speed that has characterized its work in the past in the fields of consumer goods and heavy materials for civilian use.

Why do I say "not permitted"? The reasons fall in several sectors, but, in my opinion, an outstanding one is in the limitations placed on production activities by the very men who should have the greatest interest in producing at the highest possible speed· Representatives of the Army and Navy charged with procurement and inspection.

Some cases in point will clarify the condition as I see it. While I cannot, of course, reveal the confidential sources from which these "case histories" are drawn, you may be sure that they are well authenticated

First there is the case of a producer of machine-gun parts. The specifications to which machine-tool operators in this plant work call for tolerances so close that they can never be met in high-speed production. When they are met, by slow and tedious means, even the parts produced in that one shop are not interchangeable; assembly must be made by the cut-and-try method Here is the direct antithesis of mass production methods, of the one system by which the production that we all want can be achieved And the military inspectors of this work insist in one breath that the tolerances must be adhered to; in the next breath they call for production!

Then there is the case of a shipbuilding program where work was held up for a week because the government inspector on the job insisted that the welding electrodes being used were not the proper kind for the work. This insistance continued in spite of the fact that the workmen concerned were thoroughly familiar with welding procedure It did not end until it was discovered that the inspector was using the wrong specification book! On this same job an inspector demanded that a certain part of the work be welded with 5/32-inch electrodes instead of the ¼-inch rods that were being used, again despite the practical working knowledge of the workmen. In this case, as in many others, the manufacturer must bow to the orders of the government representatives in order to keep things moving at all.

In a third case, finishing operations on 37mm anti-tank gun mount are being carried out with ½-inch grinding wheels, just because the specifications call for such procedure. In the opinion of men who are qualified by experience to know, this lengthy operation serves no good purpose as far as the final performance of the gun is concerned, and might well be eliminated, with a definite speed-up of production.

I could go on with several more examples, but I am sure that those given will serve the present purpose.

From these case histories it is apparent that a great obstacle to full-speed production is hide-bound tradition in military circles. It appears that the men who are vested with the responsibility of supervising production in various industries are seldom selected for their knowledge of the particular work which they are to control.

This brings us to suggestions for a possible solution of some of the troubles that are inherent in any system in which production control requires specialized knowledge, if production is to be kept at the highest possible peak.

Army and Navy procurement officers and inspectors should be selected from the ranks of industrial technicians, rather than from the Services. Draw them from the automotive industry for supervision of automotive problems, from welding concerns for inspection of welding jobs, from ship-building yards for control of ship-building operations If it is feared that technicians so selected might be biased in favor of their own organizations, set up a ruling that no man is to represent the government with the specific company from which he was drawn.

This procedure would probably not be looked upon with favor by Army and Navy officials because these men would not be instilled with the proper military spirit, would not hold to the traditions of the Services.

Let us assume that these are valid objections. Then give to these technicians who are to speed up production an intensive training course in the Army or Navy, thus providing such background as seems essential. This course, consuming perhaps two or three months, certainly would not hold up production any more than it is being held up at present by the sort of thing outlined in the case histories above. And when these men finish their training they would be qualified to couple the requirements of the Services with their expert knowledge of the requirements of mass production methods.

What I have proposed is merely an adaptation of the fundamentals upon which American industry has grown to world supremacy. When the right man is put in the right job, things hum; when the wrong man is invested with authority that no one can question, there is created a choke point that is all too frequently blamed on almost everything but the one out-of-place factor.

Very truly yours,

A. P. Peck

Patents and Free Enterprise

Anti-Trust Laws Can Control Abuse of Patents Without the Necessity of Destroying Patent Rights

WILLIAM R. BALLARD
General Patent Attorney,
American Telephone and Telegraph Company

The American patent system seems to do well the thing it was intended to do, namely, "to promote the progress of science and the useful arts." We are the most inventive and progressive people in the world, and during the past century and a half over two and a quarter million patents have been issued to inventors. Right now, however, there is agitation in certain quarters to change our patent laws radically on the ground that they are in collision with the anti-trust laws, that they take something from the public merely to benefit an individual, and that they are being misused by patentees. The reasons back of this agitation are wholly unsound, but there is real danger that they may prevail and kill the goose that lays the golden eggs.

A patent is not a private privilege carved out of the public domain. So far from being a means of taking something from the public and giving it to an individual, a patent is a means for getting something from an individual and giving it to the public. If a man makes an invention of the kind which can be protected by a patent, it is something which the public does not then have, and to which it has no claim. That invention belongs to the man who made it. He may, if he choose, keep it secret and practice it to his own profit. He may, if he choose, let the art die with him. If anyone surreptitiously filches his secret invention, he has his remedy at law for the injury. The patent system is designed to induce him not only to do the inventing but to disclose his invention and give it to the public gratis after the term of the patent, in return for the assurance that he will be protected in the exclusive use of his own for those seventeen years, notwithstanding the disclosure. In this transaction, it is clear that only the inventor gives up anything of substance. To purchase the residuary rights in his invention the public contributes neither money nor anything else it possesses. It gives only a promise of temporary protection for the inventor's own intellectual property so that he may, if he can, make a profit for himself during the period of protection.

As long ago as 1852 Daniel Webster stated it as plainly as this:

". . . The Constitution does not attempt to *give* an inventor a right to his invention, or to an author a right to his literary productions. No such thing. But the Constitution *recognizes* an original, pre-existing, inherent right of property in the invention, and authorizes Congress to secure to inventors the enjoyment of that right. But the right existed before the Constitution and above the Constitution, and is, as a natural right, more clear than that which a man can assert in almost any other kind of property. What a man earns by thought, study, and care, is as much his own, as what he obtains by his hands. It is said that, by the natural law, the son has no right to inherit the estate of his father—or to take it by devise. But the natural law gives a man a right to his own acquisitions, as in the case of securing a quadruped, a bird, or a fish by his skill, industry, or perseverance. Invention, as a right of property, stands higher than inheritance or devise, because *it is personal earning*. It is more like acquisitions by the original right of nature. In all these there is an effort of mind as well as muscular strength.

"Upon acknowledged principles, rights acquired by invention stand on plainer principles of natural law than most other rights of property. Blackstone, and every other able writer on public law, thus regards this natural right and asserts man's title to his own invention of earnings.

• Even in times of economic uncertainty, the patent remains the cornerstone of business and industry, large and small. In view of current attempts to undermine our patent system by attacking it as a system which fosters "trusts" and makes it possible for an inventor to establish a "monopoly," the present article is unusually timely. By emphasizing that the inventor gives something to the public, rather than taking from it a right which the public should possess; the author stresses that phase of our patent law which is fundamental, yet all too often overlooked.—*The Editor* •

"The right of an inventor to his invention is no monopoly. It is no monopoly in any other sense than as a man's own house is a monopoly. A monopoly, as it was understood in the ancient law, was a grant of the right to buy, sell, or carry on some particular trade, conferred on one of the king's subjects to the exclusion of all the rest. Such a monopoly is unjust. But a man's right to his own invention is a very different matter. It is no more a monopoly for him to possess that, than to possess his own homestead.

"But there is one remarkable difference in the two cases, which is this, that property in a man's own invention presents the only case where he is made to pay for the exclusive enjoyment of his own. For by law the permission so to enjoy the invention for a certain number of years is granted, on the condition that, at the expiration of the patent, the invention shall belong to the public. Not so with houses; not so with lands; nothing is paid for them, except the usual amount of taxation; but for the right to use his own, which the natural law gives him, the inventor, as we have just seen, pays an enormous price. Yet there is a clamor out-of-doors, calculated to debauch the public mind." (Emphasis by Mr. Webster.)

Chief Justice Marshal said of the patent: "It is the reward stipulated for the advantages derived by the public for the exertions of the individual, and is intended as a stimulus to those exertions . . . The public yields nothing which it has not agreed to yield; it receives all which it has contracted to receive. The full benefit of the discovery, after its enjoyment by the discoverer for 14 (now 17) years, is preserved; and for his exclusive enjoyment of it during that time the public faith is pledged."

It is sometimes said that patentees have a practice of prolonging the life of their patents beyond the 17-year period. This is done, we are told, by taking out improvement patents.

The simple fact, of course, is that no patentee can prolong the life of his patent by so much as a single day.

When a patent has run its 17 years, it ceases at once to be a bar to anyone in any way. The making, using, or selling of the thing covered by the patent is as free to one man as to another; and this is true whether improvement patents have been taken out or not.

And during the life of the patent one man as much as another is free to make and to patent improvements on the preceding invention. Of course, the man who makes the best improvement will, after the first patent expires, be in a better position to compete (so far as patents are concerned) than the man who makes a poor improvement, or none. If the same man who conducted a business under the first patent makes the best improvements he, of course, will have this competitive advantage; but this is the result of his effort and ability in making the improvements—not in any sense because of an extension of the monopoly of his old patent.

In this matter of making and patenting improvements there is a field of perfectly free competition. If the outsider, who wants to get in, has the ability and is willing to spend the time, money, and effort required to make and to patent the best improvements, he will hold the advantage in the business over the original patent owner when that patent expires. If he has not the ability or is not willing to make the effort, there is no reason why he should be permitted to take, free of cost, the improvements of someone else who has spent time, money, and effort in perfecting them.

We sometimes hear it said that the *assignment* of a patent—especially an assignment to a corporation—diverts it from its intended purpose and turns it to an unforeseen and undesirable end such as "the pursuit of gain." There is no truth in this.

It seems almost too obvious to require stating that the very purpose of the patent law in granting an inventor a patent is to enable him to reap a profit on the invention. The chance to do that is his reward for contributing to the advancement of science and the useful arts by making and disclosing the invention. From the point of view of the public, it is of no importance at all whether the patentee makes the profit by manufacturing and selling the invention himself, or makes it by selling his exclusive right to someone else. If he sells his patent to someone else, the purchaser, whether a corporation or an individual, gets no rights which the original patentee did not have.

Obviously either the inventor *or* his assignee may use the patent unlawfully, just as he may use any other private property unlawfully. For example, he may make an agreement or combination in restraint of trade which involves his patent, just as such an agreement may involve his grain or his horses. But the cure for this is not to decry the sale of the patent or the grain or the horses, but to prosecute the perpetrator of the agreement (whether inventor or assignee) under the anti-trust laws if he transgresses those laws.

Some seem to assume that a patentee, as distinct from the owner of other property, is under some special obligation to society. Having read Article 1, Section 8, of the Constitution and found that the granting of the patent is intended "to promote the progress of science and useful arts," they jump to the conclusion that it is the patentee upon whom falls the duty of promoting the progress of science and the useful arts. Of course, this is plain foolishness. The Constitution expressly states that it is Congress that is to promote the progress of science and the useful arts. And the precise way Congress is to promote them is stated, namely: "by securing for limited times to . . . inventors the exclusive right to their . . . discoveries." So, it is the fact that the exclusive rights are granted which promotes the progress of science and the useful arts, and not something the patentee is expected to do after the grant is made. Once made, the grant, like any other piece of property, is something belonging entirely to the grantee. It is intended for his benefit and with it he may, as with his horse or his grain, do just as he pleases. The patentee's obligation to society is no greater, and of course no less, than the obligation of the holder of any other piece of personal property. The patent is merely property he has bought by yielding the price specified by the Government.

Of course, anyone so blind as to believe that human beings have already attained such perfection that we can now thrive and progress without the stimulus of any private ownership at all will object to the private ownership of the patent right, and, since it seems easier to vilify this right as a "monopoly" than it is the corresponding monopoly in one's horse or his grain, it is natural that such a person should pick on patent property for propaganda purposes.

Quite obviously, the right of any person in any private property does, to some extent, limit the freedom of others in conducting their business enterprises (and in other ways). If A owns a farm, B, of course, is not free to conduct an agricultural enterprise that would involve planting and cultivating A's acres. Just so, if A owns a patent on an invention, B is not free to conduct a manufacturing enterprise which would involve the making and selling of A's invention. And most certainly in neither case is there any reason why B should be "free" to do such a thing.

The American idea of free enterprise is not that a man should be free without permission to do business with the property of others, but that so long as he respects the property and other rights of his fellow men he shall be free to conduct whatever enterprise he will, wherever he will, and for such time and in such way as he may choose —and especially that he shall be free, so far as possible, from interference by the Government.

The basic relation between patents and free enterprise is so simple that it can be stated in one paragraph. It is precisely the same relation as between any other private property and free enterprise. While a man's, or a company's, ownership of private property is always in a true sense a monopoly of that property, and the control of it is often referred to as absolute, nevertheless it is also always true that the use of such property, whether it be patents, or grain, or horses, is subject to the general laws governing the use of property, as, for example, the anti-trust laws. And while, as already noted, private ownership of property is necessarily a limitation on the activities of others, it is also true that private ownership and a complete control of the property involved not only promote free enterprise but are almost essential to it. No one can have a really free enterprise based upon a farm or a grocery store unless he has complete control of the farm or the store, and the same is true as to patents. The ownership of patents and the complete control they give of the invention covered are the cornerstones of hundreds of small enterprises in this country.

To propose the destruction of useful property merely because it might be used as the subject of an agreement in restraint of trade, or otherwise in contravention of law, is childish. That, in substance, is what some now propose as to patents. History indicates that oil is more likely to be used as the basis of combinations in restraint of trade than are alphabet blocks or tigers, but that is no reason for destroying or for denaturing the oil; and anyone who suggested that as the remedy would risk a trip to a clinic for mental observation.

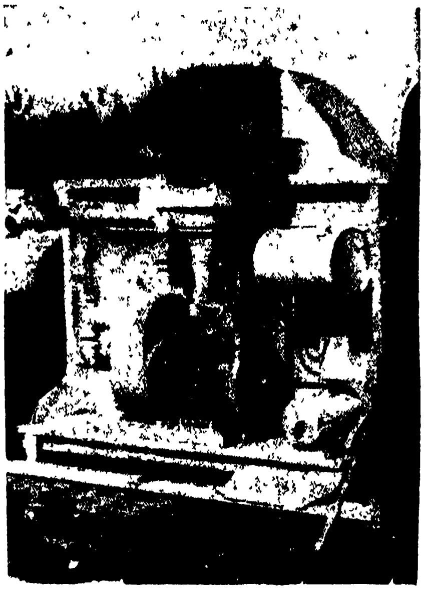
Experience shows that patents, like oil, contribute to the public welfare. Let them remain as they are and continue their good work of promoting science and the useful arts. If owners of patents use them as the basis of agreements or combinations to get control of things which the patents themselves do not cover, the remedy is not to destroy the patent right but to enforce the anti-trust laws.

Air-Conditioning Fish

Mechanical Means Used to Provide Oxygen, Keep Temperature Low When Transporting Hatchery Fish

F. WALLACE TABER

ARTIFICIAL rearing of fish fry has long been a constant headache to all concerned—not excluding the fish. Nevertheless, every state in the Union now rears fish fry for restocking depleted streams and lakes, some states boasting several million fry production annually; others only a few thousand. Nevada is in the latter category, but were she granted a handicap because of the many problems with which she must cope, she would undoubtedly be in the first rank.



Blower and motor

Fish require oxygen to live; lack of oxygen results in suffocation. Fish do not, however, utilize the O part of H_2O; they are not capable of breaking down the compound The oxygen which fish breathe is that which has been dissolved in the water The dissolved oxygen is extracted by means of the haemoglobin of the fish's blood, which comes into very close contact with the water as a result of the extremely thin gill membranes through which the blood freely circulates. Therefore, not all water is capable of sustaining fish life; fish must have oxygen dissolved in water to live.

It is likewise a well-known principle of physics that colder water has a greater capacity for dissolved oxygen than has warm water. The lower the temperature, the greater the potential oxygen carrying capacity; conversely, the warmer the water, the smaller the dissolved oxygen carrying capacity. Therefore, it is desirable in transferring fish aboard a truck not only to keep the water constantly aerated, but also to maintain a low temperature so that the water will take on the oxygen as it is passed through the liquid.

In most states, when fish are transferred from hatchery to wild streams and lakes, an ordinary air pump supplies the necessary aeration and a cake of ice maintains the desirable low temperature. Not so in Nevada! There the sweltering desert temperatures hover around 118 degrees in the shade for days on end, and a cake of ice lasts about as long as the well-known snowball. Nevertheless, Nevada fisheries experts last year carried more than 120,000 baby fish well over 2000 miles with losses so small as to be negligible.

Machinery made possible this success. Mounted on the back of a truck, a pump driven by a one horsepower engine circulates water through the fish tank. In operation, water is drawn from the bottom of the tank and discharged with considerable force from small spray jets spaced along a common delivery line. The tank is completely covered with a tight-fitting lid into which is cut a slot-like opening in the rear part of the cover. A funnel-like ventilator situated forward on the cab collects air when the truck is in motion, passes it through the spray of water, to be finally exhausted through the opening in the rear of the cover. Not only does the continual breeze adequately aerate the falling water but at the same time the evaporation thus brought about is sufficient to keep the water several degrees below the atmospheric temperature. On one trip of a hundred miles with the air temperature oscillating between 112 and 114 degrees, Fahrenheit, spring water with an original temperature of 77 degrees gained but a single degree over the entire trip. A tank of water similarly treated, but minus the ventilator, jumped from 77 degrees to nearly 90 during the first hour of running. Needless to say, the bass fry in this check tank were all dead long before the destination was reached.

A SECOND method of aeration is now being tried because of the difficulties encountered when the truck has to stand idle with the fish on board. In such a condition there would naturally be no air circulation. In these experiments a blower of the squirrel-cage type is mounted above the motor and connected by a belt to the motor shaft. The blower is in turn connected to an air duct that leads the air into the spray chamber above the water.

This mechanical method of forcing

Photos by National Park Service

Blower supplies air; pump produces water spray the air through the spray has the advantage of cooling the tank water while the truck is at rest as well as when the truck is traveling along the highway. It also produces a uniform air flow throughout the spray chamber at all times, while the flow of air introduced by the funnel mounted on the cab varies with the velocity and direction of the wind and the speed of the truck.

Ralph H. Olson, inventor of this cooling system, tested the apparatus during last July and August, the hottest season on the desert. Some 15,000 miles were chalked up under the most adverse desert conditions, with temperatures often ranging up to 120 degrees in the shade. During this time 300,000 bass and blue-gill fry were carried through in fine shape. "The fish arrived at their destinations just as lively, if not more so, than when they left the hatchery," Mr. Olsen said. "Some of the trips were as far as 600 miles one way, yet I have never used a single pound of ice even though the trips are often made during the heat of the day."

• • •

OZONE

Still Much to be Learned About its Effects

CHEMISTS are reaching a better understanding of the toxic effect of ozone on humans, concerning which there has been a surprising lack of agreement among investigators, according to Clark E. Thorp of Chicago, industrial chemist, in a report to the Americal Chemical Society.

Ozone, a faintly blue form of oxygen which is present in minute amounts in the atmosphere and is encountered in many phases of modern electrified industry, is formed in practical quantities by spark discharges and by ultra-violet rays. Spark discharges also form nitrogen oxides from air. Tests reported by Mr. Thorp show a large difference of toxicity between pure ozone and ozone containing nitrogen oxides.

"Ozone free of oxides of nitrogen is non-toxic in concentrations below 20 parts per million." Mr. Thorp says. "Ozone containing 47 percent nitrogen oxides has bactericidal properties.

"Ozone plus nitrogen oxides may be more toxic than nitrogen oxides alone and should be investigated further. The variance of opinion to ozone toxicity is probably due to results obtained with ozone containing varying amounts of nitrogen oxides."

Two hundredths of one part of pure ozone per million can be detected only by chemical analysis, but five-hundredths of a part per million is detectable by a keen sense of smell. One tenth of a part per million of pure ozone results in an easily detectable, but not unpleasant, cloverlike odor.

At one part per million, the odor still is not unpleasant, although continued exposure became annoying to 25 percent of those tested. Exposure of seven hours a day for five days did not cause irritation of nose and throat.

Three parts per million of pure ozone has no killing power on coli (bacteria) in water, or on bread mold spores in air; nor has ten parts per million any effect on mice after six hours' exposure. Fifteen parts per million bubbled through a representative sample of algae, tiny tree plants growing in water, for one hour had no noticeable effect; after six days the algae had tripled in growth.

Four hours' exposure to air containing 20 parts per million of pure ozone did not affect mice, nor produce soreness of nose or throat in humans. But 30 parts per million caused coma in mice after five hours' exposure, though coli were not killed. The mice revived when subjected to normal air. Five hours' exposure to 50 parts per million killed mice, but this proportion used in six hours' aeration of flour did not kill any weevils or affect larvae.

One hundred parts per million of pure ozone were lethal to mice in one hour, and a one-minute exposure of humans resulted in dried skin, severe sore throat. One hundred parts per million also killed 20 percent of the coli in water containing 500 coli per cubic centimeter with one hour of aeration per liter.

The effect of impure ozone, containing 47 percent oxides of nitrogen and 53 percent ozone, was quite different. According to parts per million, the following observations were reported: one-hundredth of a part per million—threshold for keen smell; two-hundredths—easily detectable to people; five-hundredths—odor objectionable to some people; one-tenth—acid odor highly objectionable, causing sharpness in throat.

One part per million, the limit at which a test was made on humans—produced headache after two hours and sore throat after three hours; three p.p.m.—kills all coli in water when coli number less than 220 to the cubic centimeter, five hours' aeration per liter; five p.p.m.—kills all coli in water when coli less than 1,000 per cubic centimeter, five hours' aeration per liter.

Ten p.p.m.—lethal to mice in five hours' exposure; 15 p.p.m.—kills algae after ten minutes' bubbling through water, and algae did not grow again in the water; 30 p.p.m.—kills all coli in water when coli less than 1,000 per cubic centimeter, five minutes' aeration per liter; 50 p.p.m.—kills flour weevils and 80 percent of larvae after 30 minutes' aeration through flour, turns flour light brown in color.

"The toxic limit for nitrogen oxides has been determined to be 2.3 parts per million by weight," Mr. Thorp says. "The toxic limit for ozone containing 47 percent nitrogen oxides is shown in this report to be only 1 part per million, which would be the equivalent of about 0.5 part per million for the oxides of nitrogen. The presence of ozone evidently increases the toxicity of nitrogen oxides to a considerable degree. Although it would require a comprehensive physiological test on humans, this action should be investigated further by some one equipped to carry out such research."

Each molecule of pure ozone has three atoms of oxygen. Used commercially for sterilizing water, purifying air, and bleaching, ozone is one and a half times denser than ordinary oxygen gas. It is created every time a silent electric discharge goes through a current of oxygen or air.

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GASOLINE—Motor fuel for highway use, reported in these pages in our February issue as totaling 22,000,000 gallons in 1940, should have been placed at 22,000,000,000 gallons.

• • •

SPORTS EQUIPMENT

Must be Conserved "For the Duration"

AT the recent National Sportsmen's Show in New York (also at numerous others held throughout the country) exhibitors generally cautioned sportsmen to treat their equipment kindly and thereby help win the war. Before long the shortage of metal, rubber, cork, and other materials will be very evident. One material which must be conserved is wool, for it is used not only for clothing, but to a very large extent in felt, and felt is utilized to a greater degree in sports goods than the average person realizes. Its application ranges from boot and moccasin linings to shoulder pads for hunters and heavy fishing tackle harness, archery arm guards and targets, camping equipment. In motor boats and airplanes it is employed to absorb vibration; it is used for canoe and boat seat cushions, helmets for participants in speed events on land, air, and sea, and so on. It finds its way into skiing outfits and many other sports costumes and accessories, golf club grips, and hundreds of other items.

Variable cushioning properties make felt an ideal shock absorber. For example, in a baseball catcher's mitt felt with non-resilient qualities must be used; otherwise the ball would bounce out of the palm. And yet, for various other purposes, high resiliency is called for, as in helmets, tumbling mats, basketball knee-pads and so forth. Thick felt insoles are unsurpassed in cases where boots are too large, especially when long hikes are in prospect. These insoles can be cut with scissors to give maximum foot comfort.

OIL TRANSPORT

On the Mississippi Will Reach 200 Million Barrels in 1942

Nearly 200,000,000 barrels of crude oil and petroleum products will be moved on the more than 5000 miles of the Mississippi Waterways System to inland refineries and markets in 1942, helping to relieve the railroads now when they are so burdened, and when tank cars are needed in unprecedented numbers for West Coast and East Coast services to replace tank ships.

The increase in the movement of petroleum on the inland waterways has been phenomenal, according to authoritative reports The estimated 1942 total will be more than four times the less than 50,000,000 barrels moved in 1933 Not only has transportation on the main waterways increased spectacularly, but new oil ports, such as Minneapolis-St. Paul, have been opened up within the past two or three years. Prior to 1939, scarcely any petroleum moved into the Twin Cities by water.

Petroleum moves in barges out of all the great oil ports on the Gulf of Mexico, from Corpus Christi to New Orleans, up the Mississippi to the Missouri, the Illinois, the Tennessee, the Cumberland, the Ohio, the Allegheny, the Monongahela, and the other navigable rivers in the system On the Ohio and Monongahela, barge-borne petroleum is transported from the southwest to ports 100 miles above Pittsburgh. On the Kanawha, petroleum reaches Charleston, West Virginia. Using the Illinois River and canal, shipments from the Gulf of Mexico can enter the Great Lakes waterways system. Up the Missouri petroleum moves to new terminals in Iowa and Nebraska.

The number of river-side oil terminals on the Mississippi system has grown tremendously. At the end of 1941 there were listed 252 terminals at 135 points in 17 states. Two years before, in 1939, only 160 oil terminals were reported. The terminals are of all sizes, some of the most modern providing storage and terminal facilities for more than 5,000,000 gallons of petroleum products.

Nearly one fourth of the country's entire refining capacity is concentrated along the Texas and Louisiana Gulf Coasts, from which the inland barge movement gets most of its supplies.

TUBING

For Electrical Insulation is Strong, Flexible

A new tubing with excellent resistance to brittleness down to —50 degrees, Centigrade, has been developed by the Irvington Varnish & Insulator Company. This transparent tubing, known as Transflex, was made especially to secure continued, effective insulation on aircraft flying at high altitudes; it has already been utilized by such companies as Douglas Aircraft and Curtiss-Wright. However, its toughness and rubber-like qualities make it useful for a variety of other industrial and electrical applications. For example, the transparency of Transflex permits quick location of wire breaks and ready identification of wires which have been snaked through it.

Can be tied in knots

Transflex is a Fibronized tubing available from size No 14 to ⅝ of an inch inside diameter; it is extremely flexible, as shown by the accompanying photograph. Its tensile strength is 3000 pounds per square inch. Its dielectric strength (conducted on a tubing with a wall thickness of approximately .020 of an inch) is 850 VPM when dry and 815 VPM when wet Water absorption is 0.4 percent in weight after 24 hours immersion.

USEFUL PLANT

Bamboo Can Supply All Human Needs

What is the most universally-used plant that grows? Is it, as many have stoutly maintained, the coconut palm? Or sorghum, maize, sugar cane, or peanut? No, not one of these, according to Dr. Willard M. Porterfield, Jr., of the United States Soil Conservation Service. It is bamboo.

There is not a category of human needs which cannot be supplied by some form of product of bamboo, declares Dr. Porterfield. Food, weapons, shelter, implements, clothes, furniture, baskets and containers, bridges, conduction pipes, paper, cable, ornaments, and many very specialized articles are made from it.

The Forest Research Institute of Dehra Dun in India believes that the final solution of the world's recurring shortage of raw material for paper will only be found in the forest and waste lands of the tropical and sub-tropical belts, with bamboo the most important product.

Bamboo has figured largely in the past history of Asiatic and many tropical peoples and has been the subject of artistic rendering in all the arts. The famous Bamboo Books, containing more than 100,000 seal characters, comprising 15 different works dealing with the history of China for 2200 years, were written on tablets made of bamboo which were strung together like a fan.

To bring the uses of bamboo up to date, a bamboo basket has been designed and used by the Chinese to protect their most important buildings from Japanese air raiders. According to W. R. Peck, Counsellor of the United States Embassy, Chungking, China, the Chinese construct a three-story bamboo framework atop buildings and load all three floors with cut bamboo. When a bomb hits, it is harmlessly detonated before it reaches the building itself.—*Science Service.*

ROAD-RAIL

Vehicle for Use in Explosives Plants

A speedy motorized vehicle which rolls on rubber tires on the highway or on a railroad track, is being used

At home on road or rail

How A Big Business Man Appears To His Wife

"LOOK at him over there, grinning to himself! Strange how little a man can change in fifteen years! The big boss one minute—and like a little boy the next!

"He was mostly 'little boy' before we were married. He'd been coming around for a couple of years, and I'd just about given him up. Then, suddenly, he was very much a *man*, rushed me off my feet and almost before I knew it, we were married.

"When we were newlyweds he was only a bookkeeper, and he'd come home in the evening all tired and discouraged. Other fellows at the office had been promoted, and he didn't know what to do about it. One night I forgot myself and said, 'If *you* don't do anything about it, Mr. Stick-in-the-Mud, no one else ever will!' Then I was sorry, when I saw how I'd hurt him.

"But it must have made him think hard, because one evening the following week he came home looking as though he'd just robbed the piggy bank. He told me he'd enrolled for a course of executive training. He thought I'd be angry, because we were still paying for the furniture. The 'little boy' and the man, all mixed up!

"After that, his whole point of view toward business seemed to change. One promotion followed another, until a few years later he became Treasurer of the company. Now he's beginning to surprise me. Says he expects to be Vice President soon!

"Of course, he's just as modest as he ever was. He'll tell you he got the breaks, but I know better. He *got* the breaks because he'd learned how to grasp them when they came. He's really smart—and so was I when I said 'I do' to a little boy turned man!"

• • •

What does the lady in *your* life think of *your* success? Get more of the Alexander Hamilton Institute's story in the famous little book, "Forging Ahead in Business." Tells how the Institute's timely training is helping thousands of men to do a better business job in these wartime days. Just clip and mail the coupon—today!

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Position

to eliminate some of the hazards in the movement of explosives at arsenals and powder depots. Called the "Auto-Railer," the vehicle employs special rubber tires, developed by The B. F. Goodrich Company, which work in conjunction with conventional flanged guide wheels for operation on railroad tracks. Designed and manufactured by the Evans Products Company, the Auto-Railer has a top speed forward or reverse of 60 miles an hour, either on highway or rail, and, thanks to the windshield-wiper action of the non-skid treads, it can be stopped as quickly on the rails as can a modern automobile on the road.

The transition from highway to rail takes but a few seconds. The rail assembly is operated by a hydraulic jack, controlled from the driver's seat, which lowers or raises the flanged steel guide wheels. On the rails, the rubber tires bear a portion of the load normally carried entirely by the flanged rail wheels.

Weighing 8750 pounds, and capable of carrying 3000 pounds of explosives, the vehicle is completely spark-proofed, with exterior wiring throughout, while the cushioning properties of the rubber tires eliminate jolts and jars.

Several of the vehicles are already in use at one of the Ordnance Department's bomb and shell loading plants in Ohio, and more units are in manufacture for use in other arsenals.

PSYCHIC RESEARCH

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. Further reports of The Scientific American Committee for the Investigation of Psychic Phenomena will be published in forthcoming issues. ●

REPAIR KIT

For Nicked and Scratched Furniture

With the proper materials available, enterprising householders can, with but little practice, restore marred furniture surfaces to the appearance of the original condition by removing scratches, filling in nicks, dents, gouges, and so on.

A new furniture finish repair kit, just announced by the American Household Bureau, contains every essential material and piece of equipment necessary to turn out professional-looking repair jobs quickly.

This new kit contains an assortment of shellac sticks, bottles of light and dark stain, shading lacquer, alcohol lamp with fuel, spatula, scratch stick, liquid penetrating scratch polish, steel wool, felt rubbing pad, shellac rubbing liquid, sandpaper, and touch-up brushes. These materials and equipment make it possible to repair any finely finished furniture surface in a matter of a few minutes time.

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MAN MADE—Hardly a single component of an airplane or the fuel it burns or the oil which lubricates it or the liquid which cools its engine is a simple, natural product; even the metals of which it is in part constructed have been so changed by scientific research that metallurgists of 20 years ago would not have known them.

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WINCHES

Pull Army Cars Out of Trouble

Half-Tracs of the United States Army are designed to go where no other vehicles except tanks will go. This means that the reconnaissance units and personnel carriers will go through mud and water as well as across the roughest kind of terrain, not excluding trenches and shell holes. However, there is a type of ground which is closely akin to quick sand—a surface so fluid that any vehicle, even with tractor belt support, will sink. In order to take care of such conditions, the new Half-Tracs designated for quick-sand territory are being equipped with sturdy winches which drive from the transmission. These winches are used not only to help pull the vehicles out of difficult places, but for any other purpose requiring a winch.

Hard to stop; hard to stick

The winch on Half-Tracs made by White Motor Company is mounted on the front so as to be more quickly available. In this handy location it is always ready for action. The vehicle can be headed in wherever direction the winch is needed and it is never necessary to unload the Half-Trac in order to use the winch, as would be necessary if it had a body location. With this equipment, the Half-Trac is ready for any eventuality and becomes a vehicle of even greater utility.

PIERCING FOG

Yellow Lenses Hold No Advantage

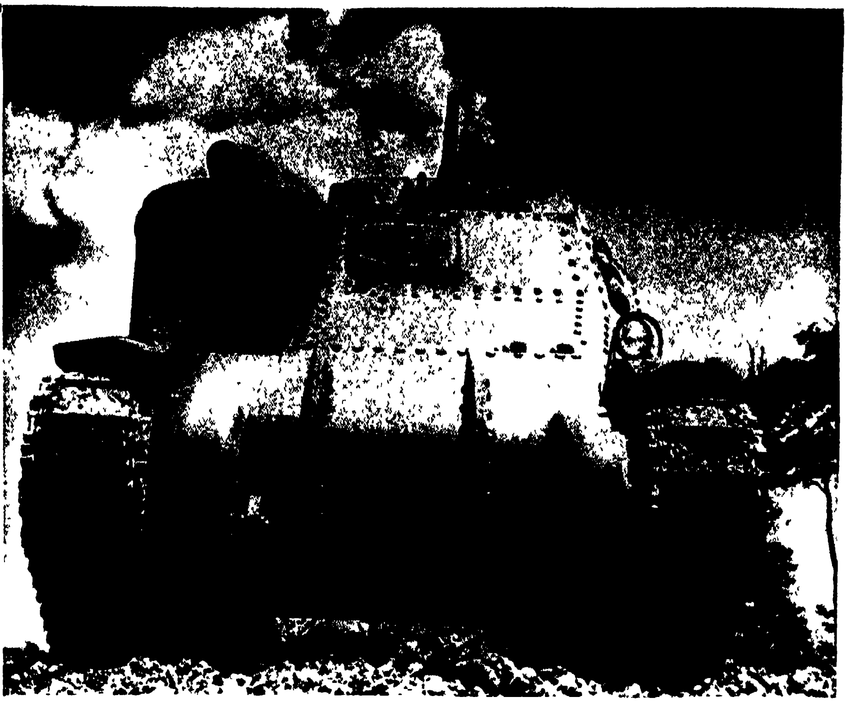
That yellow light is no better at piercing fog than the light of an ordinary tungsten lamp is shown by experiments recently carried out by Dr. Matthew Luckiesh, research physicist and Franklin medalist, and L. L. Holladay, of the Lighting Research Laboratory of the General Electric Company, Nela Park, Cleveland, and reported in the *Journal of the Optical Society of America.*

The so-called fog-lamps, consisting of yellow lenses which absorb from 20 to 35 percent of the tungsten-filament light, must contribute something to the seeing to offset the loss due to less light No satisfactory tests have been published, but the present investigation makes it more than unlikely that they have any advantage Similar fog-piercing claims have been made for the new sodium lamps. In this case there is no loss of light by colored filters, for the light is inherently yellow and practically monochromatic. Yet even this lamp showed no significant superiority over the tungsten lamp in fog-penetrating qualities.

The two lamps of equal intensity were tested side by side in clear weather, moderate fog, dense fog, mist, and snow. They were tested by day and by night. Also, a pair of lamps of low intensity and a pair of high intensity were used. Many experienced observers made many readings on a Luckiesh-Moss visibility meter at a distance of 1000 feet No significant differences showed in the averages.

The report explains that the fog-penetrating power of a light does indeed depend on its color or wavelength, as has been generally known. Thus, blue light, which is of short wavelength, penetrates fog less than red light, which is of long wavelength. The sodium lamp emits yellow light that is practically of a single wavelength. This wavelength is about midway between those of the red and blue lights. Hence the fog-penetrating power of the sodium light is just about middling.

The white light of the tungsten fila-



Men in the Armed Forces

—Soldiers, Sailors, Marines—

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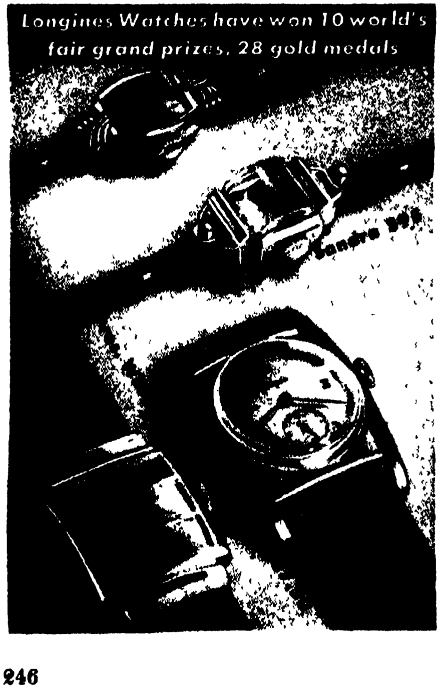
Longines provides watches in a wide variety of style but in a single variety of quality. Every Longines Watch is made to one standard that is world recognized for greater accuracy and long life, and time-tested by 76 years of use. The excellence and elegance of Longines Watches have won them 10 world's fair grand prizes, 28 gold medals and more honors for accuracy than any other timepiece. Longines-Wittnauer jewelers show the new Longines Watches; also Wittnauer Watches, a companion line of moderate price from $29.75—product of Longines-Wittnauer Watch Company.

Prices Include Federal Tax


Longines Watches have won 10 world's fair grand prizes, 28 gold medals

ment contains all the colors from red to blue. It is true that the blue rays are cut down by the fog, but the remaining red rays have a fog-penetrating power superior to the yellow light of the sodium lamps. This evens the score.

METAL "WHALE"

Has Appetite of 25 Tons A Day

Twenty-five tons of steel is the daily dish of this whale-like machine in the metal conservation department of the Westinghouse Electric & Manufacturing Company. When parts of motors, generators, and other electrical machines are punched out of steel sheets, many odd-shaped pieces are left Fed to the furnaces of steel mills, this scrap again becomes usable steel valuable to the nation's war effort But because the scrap is worth $3 a ton more if cut into sizes that fit easily into the furnaces, it goes first to the "scraphouse whale"—a great shearing machine driven by a 50-horsepower motor. This mammoth shear bites off chunks of five-inch-thick metal as easily as scissors snip a piece of paper. Each month it helps salvage enough steel to build 30 medium Army tanks—one a day.

Five-inch-thick metal at a bite

DOUBLE CHECK

On Insecticide Reveals Unwanted Features

Insecticide chemists of the U. S. Department of Agriculture have a continuing program of trying to find new and better insect poisons. What they seek are new chemicals that, on the one hand, are deadly to insects and, on the other, are not harmful to humans. They first synthesize new compounds which entomologists then test on insects. If results are promising, a stock of the material is sent to San Francisco where the Bureau of Agricultural Chemistry and Engineering and the Stanford University School of Medicine cooperate in maintaining a pharmacology laboratory to find out whether new poisons are safer than the poisons they would displace.

Entomologists are working particularly to find safer substitutes for the lead, arsenic, and fluorine poisons now in use.

Recent experience with the one new poison, reported by Bureau scientists Wilson, DeEds, and Cox in *Cancer Research*, illustrates how this protective research operates. A compound called "2-acetaminofluorene" tested well as an insect killer At the Stanford laboratory heavy single doses were not harmful to rats and rabbits. The animals eliminated the poisons So far, so good! But it turned out that with lighter doses in the food day after day, the growth of the animals was checked and they sickened and died within 100 days. Not so good!

To make the test even more thorough, the dose was reduced until it did not check growth—and the result was even less favorable. After continued feeding for from five months to a year it was discovered that even minute doses were causing cancer in many of the rats. When this report came back to Washington, the work with this new insecticide was dropped. Entomologists are not much interested in a poison that might cause cancer—no matter how effective against insects.

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PREFABRICATED — The "monocoque" engineering principle of airplane construction is now being employed in prefabricating houses. By this method the walls are glued to the framing members and become stressed covers carrying part of the weight burden.

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ICE GHOSTS

Difference Between Solids and Liquids is Not Sharp

Ghosts of ice lurk in water melted from water that has been frozen, and other liquids have some slight residual structure which is like a vague recollection of a former crystalline solid state.

This finding of science was reported by Dr. John G. Kirkwood, professor of chemistry at Cornell University, in a lecture under the auspices of the Society of the Sigma Xi, the national fraternity for the promotion of scientific research.

When a solid melts, Dr. Kirkwood explained, the long-range crystalline order, that extended throughout the whole mass of the solid, disappears completely, but some trace of the short-range local organization persists. Each molecule in the liquid tends to retain a smaller or larger group of its former neighbors about it.

The description of liquids as mobile and formless, and of solids as rigid and resistant to any attempt to deform them, is not a satisfactory distinction. Glasses and other vitreous substances are to be regarded as under-cooled liquids—liquids that have solidified without crystallizing but which under different circumstances would have crystallized. These have strength and rigidity, while true crystalline solids may exhibit creep and plastic flow at elevated temperatures.

Liquids and gases are qualitatively similar in structure and the qualitative distinction vanishes entirely above the critical point. Both possess a certain degree of local order. Crystalline solids, on the other hand, possess a high degree of structural order extending over wide domains.

Only at the absolute zero of temperature is an ideal crystal, possessing complete orderliness, possible. As the temperature is raised, various types of disorder set in, until at last the crystalline structure is disrupted and fusion begins.

MOLDING

Of Plastic, For Use With Linoleum

For use with conventional linoleum and with the wall-lining material designated as Linowall, a new line of plastic trim has been introduced by the Armstrong Cork Company. Included in the line are binding strips, cap strips, inside and outside corners, and right and left-hand end stops. Corners and end stops have floor and wall flanges which extend behind the linoleum to anchor them in place. Installation is said to be simple and the units are available in a range of colors to harmonize with shades of linoleum

MIMA MOUNDS

Curious "Geological" Formations Turn Out to be Artificial

The origin of "Mima mounds," large oval-shaped structures which dot the prairies of western Washington, and have long puzzled geologists, was explained recently by Dr. Walter W. Dalquest of the University of Washington and Dr. Victor B. Scheffer of the United States Fish and Wildlife Service of Seattle, who gave the solution in the *Journal of Geology* (Chicago).

According to the scientists named, the mounds, some as large as 40 feet across, were formed over a period of thousands of years by generations of pocket gophers.

The Mima mounds—so named from Mima prairie in Thurston County, Washington, where the mounds are largest and most numerous—were first discovered a century ago. Since that time geologists have believed them to be formed by geologic processes.

The mounds, round or oval in shape, are ten to 40 feet in diameter and one to seven feet in height. They are formed of loose dirt and gravel. Thousands are found scattered through western Washington, giving the impression of huge spheres nearly buried in the earth.

The pocket gophers which formed the mounds migrated into western Washington shortly after the last glacial period when the outwash prairies

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The Strange Case of The Invisible Evidence

DEATH had struck in the night.

A fleck of copper on the suspect's knife was the only clue. But with this trifling bit of evidence alone, criminologists using the *spectrograph* were able to prove that the knife had cut copper. By the percentage of constituents and impurities present, they identified that fleck as having come from that specific telephone wire. The case was solved—a murderer convicted.

Dramatic as has been the record of spectrography in criminology, such spectacular feats are dimmed by the everyday accomplishments of spectrographers working in science and industry.

With spectrographic equipment, metallurgists develop and control the metal alloys now so vital to our national defense. In the food and chemical industries, spectrography stands guard against contamination and adulterating impurities.

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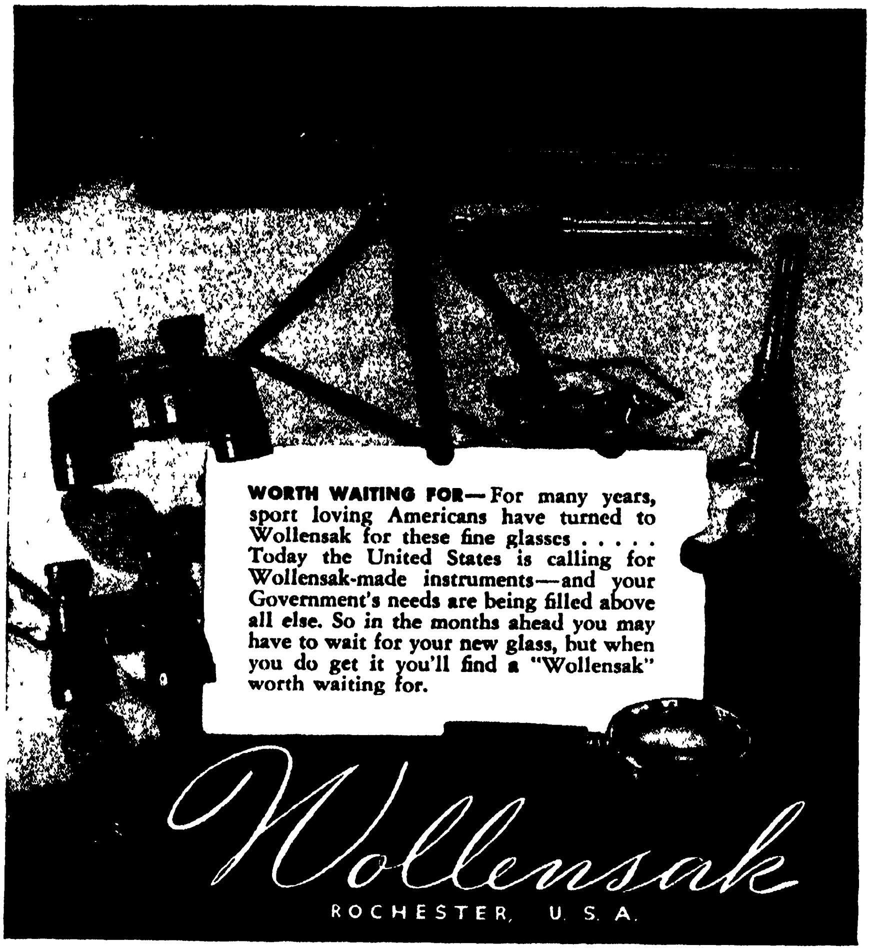

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produced by the melting glaciers were quite smooth. The process of continual burrowing, which loosened the soil and stimulated the growth of vegetation near the burrow, gradually produced the mounds.

The theory is strikingly confirmed by the fact that large rocks, too heavy to be moved by gophers, are found at the base of each mound. This results from the fact that gophers burrow around and beneath large stones, permitting them to settle.

Previous attempts to explain the mounds include the theories that they were formed by the thawing and freezing of water, by the activity of ants, and by ancient Indian tribes.

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The blank cartridges are inserted under the threaded bases of the two firing-pin housings that are attached to the main body of the unit. They are easily replaced after being fired

STOPS DRIP

Cork Coating For Pipes, Tank, Walls

SEVERAL months ago there was reported in these columns the development of a plastic cork coating which could be sprayed on pipes, walls, ceilings, tanks, and so on, to prevent condensation drip. This product, marketed under the name of NoDrip, has now been improved in composition to a point where it can be quickly and easily applied by using an ordinary paint brush.

In practice, the cork composition is spread to a thickness of ¼ of an inch over any metal, concrete, tile, or other surface on which condensation tends to form The cork composition stops dripping from such surfaces and also acts as a protective coating, preventing rust on metal surfaces It can be painted in any color

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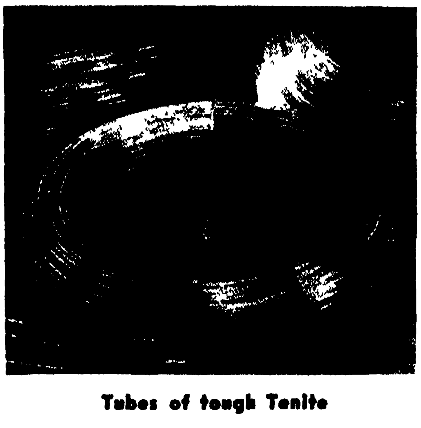

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No 9 "	1¼"	1 "	16.50	35.00

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No 2	"	¼"	" 10.00	" " "	27.50
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No 4	"	½"	" 12 50	" " "	32.00
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SIZE	H P	R P M	C F M	PRICE
24"	1/6	600	4200	$45.00
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General Electric A.C. 110 volt motors.

	RPM	cu ft per min	Price
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10"	1500	550	13 50
12"	1750	800	18 00
16"	1750	1800	21 00
16"	1140	1650	27 50
18"	1750	2500	24 50
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Has Thermal Overload Device Positively dependable and protects motor in case pump stalls

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Unconditionally Guaranteed for One Year.

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TYPE	H P	R P M	CU FT MIN	INLET	OUTLET	PRICE
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0½	⅛	1750	350	6½"	3¾"	25 00
1	1/6	1750	535	6 "	4½"	30 00
1¼	¼	1750	950	7½"	6 "	37 50
1½	½	1750	1900	9½"	7 "	75 00

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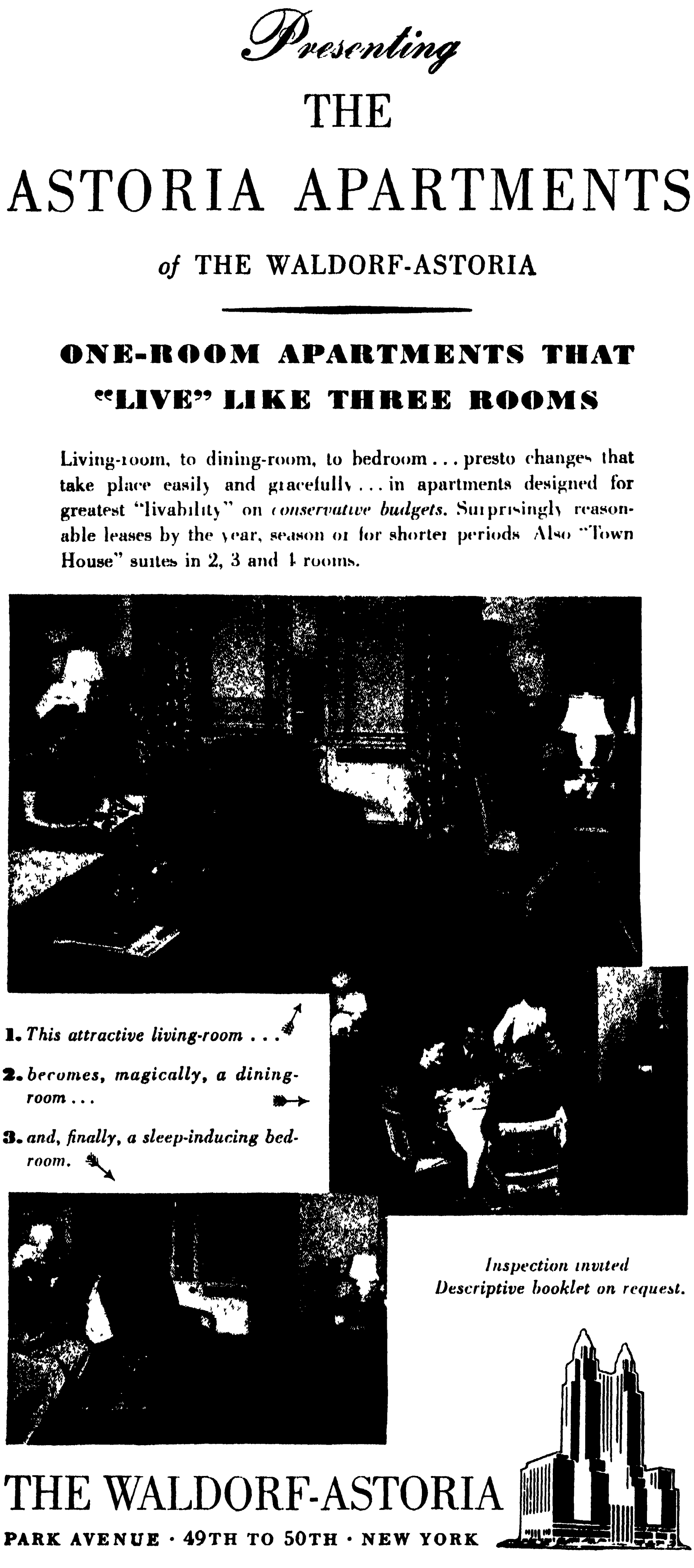

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lengths. The Tenite of which it is formed is virtually unbreakable.

The ends of these new plastic tubes may be readily adapted to standard flared fittings with the same tools that are used for copper tubing. Standard thread-cutting tools can be used on the larger diameter tubing, the wall thickness being .0625 of an inch.

● ● ●

HUMAN EAGLES—The number of civilian airplane pilots in the United States passed the 100,000 mark during 1941. At the close of that year there were 60 percent more civilian pilots than the 63,113 reported the year before.

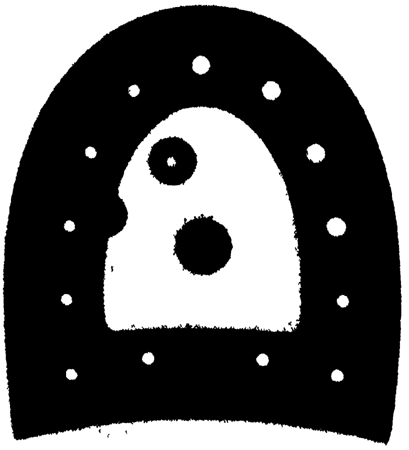
● ● ●

RUBBER HEELS

Inspected for Perfection With X-Rays

With millions of rubber heels going to our military forces, the necessity for rigid inspection of the finished heels has become even more important. One of the conditions found in defective heels in the past has been occasional misplacement of the steel washers which are imbedded in the rubber heel to hold the nails which attach the heel to the shoe.

Misplacement of one or more of these washers in the heel means that when the nails are driven in, they will have nothing but rubber to hold them in an upright position. Under severe wear they might give way, making the heel loosen and wobble. To make certain that every washer is in its allotted place, The B. F. Goodrich Company has installed new type X-ray machines in its principal rubber heel manufacturing plant.



Not acceptable

The stream of rubber heels which comes from the vulcanizers passes through these machines, at each of which sit keen-eyed, alert girls, their eyes fixed on the moving heels as the conveyor belt carries them under the X-ray eye.

If a single washer is even minutely out of place, so the nail will not go cleanly through it, this machine immediately detects it, and the heel is discarded. The proportion of rejects is minutely small, compared to the flood of products which go under the machine's searching gaze, but the operation of the X-ray machine is one more step in product perfection before it reaches the consumer.

X-rays detect out-of-line washers

PAPER BLEACHING

Chlorine Conserved by Change in Process

A PROCESS of bleaching paper pulp stock, which promises to reduce substantially the amount of chlorine needed for this important purpose, has as its basic principle the addition of the chlorine to the pulp for bleaching purposes while the pulp is flowing through a piping system and is in a state of turbulence. This method of application, the inventors of the process state, insures a uniform mixture of chlorine and pulp, so that the pulp is evenly treated and the chlorine is used with maximum efficiency. In processes now in common use, some of the chlorine is generally wasted.

An automatic system of chlorinating paper pulp, that embodies the new process, has been developed by the Mathieson Alkali Works and the Gulf States Paper Corporation, working in conjunction. In this automatic system, the rate of feeding of the chlorine is controlled by an air-operated regulator, which varies the amount of chlorine being added in exact proportion to variations in the amount of pulp flowing throughout the entire piping system.

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B 2(J 3)	Amp Hrs 37	Ea	5 50
M-8	Amp Hrs 11	Ea	2 00
I 20	Amp Hrs 13	Ea	2 50
I -40	Amp Hrs 25	Pr	4 00

All cells 1 2 volts each

Above prices are per unit cell For 6 volt system use 5 cells 12 vt —10 cells, 110 vt —88 cells Note On all cells 75 amps or less an additional charge of 10% is to be added for trays

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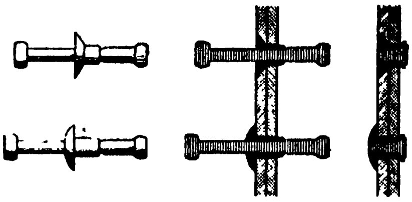
BLIND RIVETS

Can Be Set From One Side Only

A NEW type of aluminum rivet for light-weight metal assembly has been developed which can be applied and headed up in locations where the workman has access to only one side of the work. Application and heading up is accomplished with a pneumatic "gun" which completes the operation at a rate of 540 solid rivets per hour or 1200 hollow rivets

One of our photographs shows the pneumatic gun in operation; the drawing shows two types of solid rivets and indicates the method of application



Two types of blind rivets

The rivet, before being placed in position, is similar in appearance to the two views at the left in the drawing. Each rivet is a two-piece assembly, the stem sliding on the rivet body proper. The center view in the drawing shows stem and body in position for heading up; the third view gives a cross section of two completed rivets. These rivets are of the self-plugging type; in a second type the stem falls out of the rivet after it has been used to produce the inside head, leaving a hollow unit in place.

Air gun sets rivets

Heading up of these new rivets, called Cherry Blind Rivets, is accomplished by a combination push and pull motion imparted by the pneumatic gun. This tool has a piston which attaches to the head of the stem; an area surrounding the piston applies pressure against the factory-formed head of the rivet to hold it in place When the gun is operated, the piston pulls the enlarged stem section and finally the head at that end into the shank of the rivet. This movement enlarges the shank and finally forms the head on the opposite side of the work The stem is then broken off flush and any protruding part is trimmed off with a cutting tool. The rivetting gun used for this work operates on 90 pounds air pressure and exerts a 1300 pound pull on the stem

TAP RECONDITIONER

Gives New Life to Old Taps

DESIGNED to alleviate current difficulties in securing the vast numbers of precision ground taps required for war production needs, a tap reconditioner has been developed by Detroit Tap and Tool Company. Combining in one unit facilities for chamfering, for spiral pointing and for point polishing, the tap reconditioner serves to eliminate delays in tap replacements by simplifying reconditioning of taps. In addition, the tap reconditioner is said to reduce tapping costs by increasing the output per tap during its useful life The machine thus also means the avoidance of delays in securing tap replacements by endowing old taps with new life, time after time.

The tap chamfering unit, located at the left of the machine, is of the precision collet type, assuring maximum locating accuracy with quick changes. Taps of from two to seven flutes may be handled through the provision of an indexing drum. Safety stop pins limit the movement of the chamfering unit for taps of different numbers of flutes. A manual type diamond dresser is provided for the chamfering wheel. Hand-

Eliminates tap-replacement delays

wheel adjustment for wear of wheels is provided by mounting the entire grinder assembly on rails.

The spiral pointing unit to the right of the machine employs a saucer type wheel, and its fixture is designed to accommodate taps from the smallest machine screw to ½ inch diameter, using the same precision chuck.

MOTOR

Light Weight, Designed For Aircraft Accessories

A NEW direct-current, explosion-proof motor, built to United States Air Corps specifications, is now being produced in a range of powers from .005 to .2 horsepower, wound for 12 or 24-volt operation. These small units, some of which employ glass insulated wire, are light in weight by virtue of the magnesium alloy frame employed and the use of aluminum bolts, screws, and other small parts.

These motors are being employed to drive airplane accessory equipment, such as fuel pumps, deicers, propeller featherers, and recording and control devices.

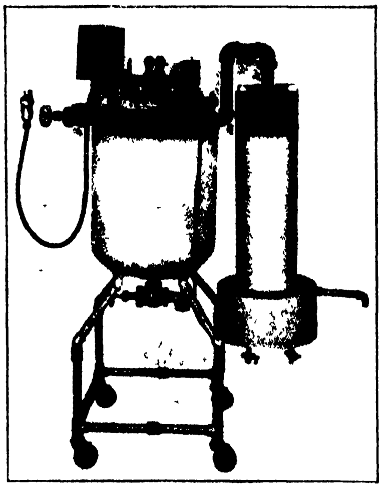
SOLVENT RECOVERY

Made Practical by Air-Cooled Still

THE necessity for full recovery of chlorinated solvents (used principally in vapor type degreasers) in industrial plants, due to O.P M 's order M-41 governing the restricted rationing of such solvents, brings a timely development by the Phillips Manufacturing Company of an electrically operated and controlled, fully automatic, air-cooled, portable still and condenser The unit is constructed to recover perchlorethylene, and can be modified to recover carbon tetrachloride and triclorethylene.

Principal feature of these stills is that all heaters and controls are mounted integrally on the easily removed pot head, assuring easy cleaning and servicing, as well as access to the pot with no fixed fittings on the interior to trap solids.

In operation the still is plugged into a grounded circuit receptacle, and dirty solvent is then pumped or poured into the pot. A sealed float switch indicates by a green pilot lamp when pot is full, and automatically energizes the heaters and starts the cooling fan on the condenser tower. When the liquid level drops to a point just above the heater, the float switch cuts off the heater and pilot lamp until a new charge of dirty solvent is placed in the pot. When the oil residues reach a pre-determined specific gravity and temperature, indicating a 98 to 99 percent solvent recovery, the heater is de-energized, and a red pilot lamp signals the operator to dump the residue before filling pot.



Air cooled; recovers solvents

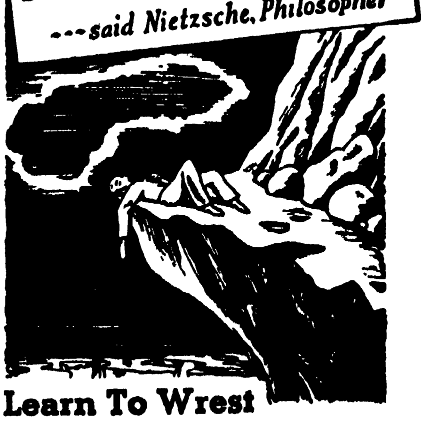
The still produces 15 gallons per hour. Operating on single or three-phase, 220 or 440 volts, 60 cycles, A.C., it is classified under maintenance equipment priority rules

COUNTERSINK

With Adjustable Depth Gage And Center Drill

COUNTERSUNK holes can be rapidly produced to accurate depth for rivets and screws without the need of particular care on the part of the operator through the use of a new unit produced by the Aero Tool Company. A center drill is provided which makes it possible to start holes accurately to punch-marked locations. A micrometer depth adjustment, built into the tool and carrying graduations reading in thousandths, limits the end movement of the countersink.

LIVE DANGEROUSLY
...said Nietzsche, Philosopher



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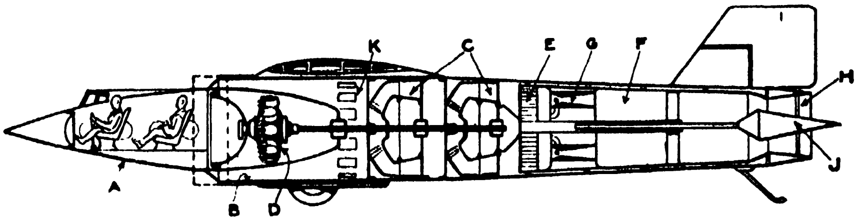
Jet Propulsion

Italian Experiments With an Airplane That Uses No Propeller for Flight at High Altitudes

ALEXANDER KLEMIN
Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim School of Aeronautics, New York University

We have had occasion to refer to the news from Italy that a jet-propulsion machine has been flown somewhere out of Milan at the Forlanini aerodrome Somehow or other, *Flight*, of London, has obtained more definite information on the new jet-propulsion aircraft, which is perhaps the very first machine ever flown without an airscrew. It is the conception of an Italian engineer, Campini, and has as its objective the replacing of the orthodox propeller power plant which loses efficiency at high altitudes.

The design of the airplane as a whole is of no particular interest, but the sectional view shown in the sketch illustrates what is of great interest, namely: the principles of the new power plant At (A) is the front of the cabin in which two occupants are seated; (B) is a cylinder enshrouding the radial aircraft engine. Air is subjected to an initial compression by the forward motion of the aircraft and is additionally compressed by means of two blowers, (C), driven by the engine. The exhaust of the engine discharges directly into the main airstream, adding heat and still further increasing the pressure of the air At low altitudes, apparently the engine drives an ordinary propeller, and behaves like a conventional power plant For high altitude flight, a further supply of fuel is introduced into the combustion space (F), into which the compressed air and fuel are guided through (E) and the annular mixing chamber (G). The products of combustion are discharged through discharge nozzle (H), with cone (J) for varying nozzle orifice. The reaction of the jet issuing at (H) supplies the forward thrust. Some reports have it that even at low altitudes, the apparatus can function purely as a jet reaction device.



Sectional view of the original Campini jet-propulsion plane design

The above description is not adequate and does not give us information as to the possible efficiency of the apparatus, but in these days of secrecy and censorship, we must be thankful for having even meager data.

TEMPLATES

Rapid Process Used in Aviation Industry

In aircraft production work, at least one extra copy of a template is always needed and sometimes as many as six may be required. With the conventional hand method, each time a work template is needed, it is necessary to scribe laboriously a duplicate copy of the master layout on a metal sheet, using the master as a reference drawing. The process may require hours, days, or weeks depending on how large and complicated the master drawing may be

Under a new electrolytic process, developed by Lockheed Aircraft, a work template can be produced in five minutes! There are only three steps in making work templates by the electrolytic process: The preparation of the original drawing by the engineer, the scribing of the drawing on a specially treated metal sheet to make the master layout; and the transfer of the scribed layout to an inexpensive metal copy sheet from which the work template will be cut The copying operation is routine and can be readily mastered by an unskilled employee. Besides the saving of time, the errors possible with hand work are eliminated.

The electrolytic process may be described as follows: A master layout is scribed from an engineer's drawing on a piece of galvanized sheet iron of suitable size and thickness, the surface of which has been prepared with a special coating of insulating paint. The lines produced by the scribe are very accurate and extend through the insulating paint coating into the metal surface. The layout thus formed is sprayed with a transfer solution and the wetted surface is pressed into firm and uniform contact with a copy plate. An electric current of suitable intensity is then passed between the plates, resulting in the layout on the master plate being transferred to the copy plate. At the end of a few seconds the press is released and the two plates removed, separated, washed, and dried. The copy plate is given a thin protective coating and is then ready for immediate use by the template cutters. Any number of copies can be made from the master plate, and, if the press is large enough, a 48- by 144-inch plate can be used. The cost of templates produced by this method is extremely low Almost any hydraulic press may be put into service for the work.—*A. K.*

MULTIPLE MOWER

Keeps Grass on Air Fields in Proper Trim

With the enormous number of air fields to be put in service by the Army and Navy, concrete or other hard runways become peace-time luxuries and, because they have high visibility, invite bombing attacks. Properly conditioned turf becomes of great importance But the rub lies in the words "properly conditioned." How can an enormous field of say 500 acres be kept in condition? The modern golf course equipment using a seven-gang mower cannot be operated at speeds exceeding six miles an hour and at this speed can only cut 11 acres an hour or 88 acres during an eight hour day. That would mean five and one half days to trim a 500 acre flying field

To meet the difficulty, the engineers of the Worthington Mower Company have developed a gang mower hauled by a fast and powerful tractor which operates efficiently at 20 miles an hour. At this speed the mower has the enormous capacity of 368 acres in an eight hour day

The mower is shown in our photograph and it involves many new principles. Heretofore all types and styles of cutting units have established the height of cut from the ground up. On rough air field conditions at high speeds the rollers and casters transmitted all shocks, jars, and vibrations to the cutting unit. In the new framework, the rear of the cutting unit is suspended from the frame and the height of cut is regulated through this suspension so that nothing touches the ground except the large pneumatic rubber traction tires. The increased simpleness of operation can be readily understood thereby.

Airport grass must be dense

A thick, dense turf is helpful on an airfield because it covers loose particles of stone, gravel, and so on, which are a source of considerable danger to metal propeller tips A thick, dense turf also helps to absorb rainfall but a thick, dense turf is only developed by frequent cutting Hence, the great advantage to be derived from the new, high-speed mower.—*A. K.*

FLIGHT CLOTHING

Being Developed for Alaskan Use

Alaska is going to assume increasing importance in our operations against Japan and it is obvious that flight clothing used during the Alaskan winter must give protection both inside the airplane and while walking outside away from an electric outlet

Therefore, both heated and unheated clothing is being developed in the Equipment Laboratory of the Materiel Division of the Air Corps at Wright Field Unheated suits have been made of various types of insulating materials such as furs and quilted down Electrically heated units meet the requirements of temperatures as low as −60 degrees, Fahrenheit The heated suits are apparently worn as underwear beneath light flying clothes or a coverall One type uses a coiled wire heating element; another type eliminates 95 percent of the wire by using a carbon impregnated material which conducts the current through the material itself. The regulation is obtained by changing electrical resistance. Heated gloves and shoes are used with the suit. It is even claimed that the heated suit, gloves, and shoes provide sufficient heat inside an unheated cabin to eliminate frosting of the windshield.—*A. K.*

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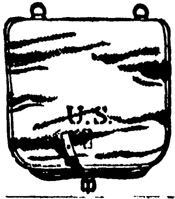

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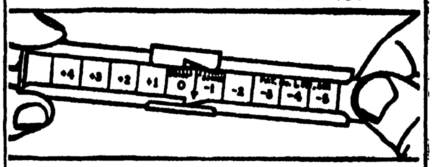

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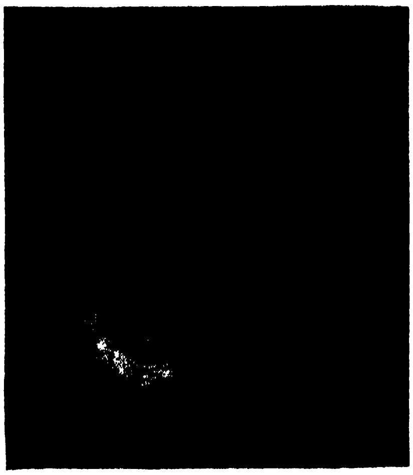
Spotlights Solve a Problem

CONTAINED in a shipment of rough diamonds received by Reinhold Brothers, New York City, from an African exporter, was a rough diamond less than a quarter of an inch in diameter. It was distinguished from the other diamonds by the fact that on one of its faces was engraved the letter "V." This was quite a find, so the importer asked us to make a picture of the diamond showing the engraved V as clearly as possible.



A "V" in the rough

That was easier said than done, even though on the surface it seemed like a simple job of cross-lighting. The problem was to light the tiny walls of the letter with sufficient brightness to make them prominent, at the same time creating a dark background for the letter *within* the glass itself. The subject was not to be tampered with in any way, the job was to be done entirely with light.

To obtain a fair magnification of the stone, we used a 5 by 7 view camera, its bellows extended the full 19 inches, equipped with a 6-inch Dagor lens. Reaching as close as we could with this set-up, we obtained a fair magnification, later enlarging the diamond image to a diameter of a little more than 1½ inches, even though the Super Ortho Press film we used was developed in 1-to-1 D-72.

The lighting arrangement took two or three hours, believe it or not, because the clean-cut result we strove for did not come as easily as we had thought it might. We used from one to three spotlights, these being employed because of the great control possible, placing the spot-focus beam as nearly on a line with the stone as possible. The idea was to shoot the light through the side of the stone. We found, eventually, that two spots, the direction of which may be seen from the position of the shadows in the illustration, would do the trick better than one or three, the first not being sufficient to bring up sharply both lines of the letter, and the second tending to flatten the crispness obtained by using two spots.

The letter V formed by the two shadows is purely accidental but helps the subject.

Are Flash Bulbs Scarce?

RECENTLY an ugly rumor went the rounds that there were to be no more flash bulbs, at least not for a very long time, because the Government needed the aluminum. However, the veil has been lifted and it appears that an order had gone forth freezing distribution of flash bulbs temporarily. Now the order has been lifted and flash bulbs are again available, though the supply is not inexhaustible. In any event, we can take nothing for granted. The war is still on, and freezing orders may come again. The general advice is to behave, buy only in normal quantities and thereby show the Government that you will use flash bulbs economically and not in the profligate manner we have been accustomed to when things were different a short while ago. In that way, sufficient materials may come through to make it possible for the manufacturers to keep the amateur and professional supplied.

Reducing Static in Darkroom

SPRAYING moisture into the darkroom air through an atomizer helps to reduce the presence of static, which is the cause of lint and dust adhering to the surfaces of negatives. If you have been having trouble on this account, try this atomizer stunt and see if it helps.

Large vs. Small Cameras

THEY say larger cameras are coming back. The illustration shows one lad who is bringing them back in a big way, a 5 by 7 Graflex, no less! There is considerable talk on the subject of miniature versus larger cameras, but it is surprising how many persons still think highly of the 35mm minia-

Staging a come-back?

ture, believe it is superior in many ways to the larger cameras. The general feeling, however, seems to be that the 2¼ by 2¼ negative is the smallest feasible, yet the admission is frequently made that the miniature—because of its small, compact size—is still the camera par excellence for candid work and wherever it is advantageous to keep the camera on one's person most of the time.

Sound Films Train Workers

Workers in armament production are being trained through the medium of sound films produced under the direction of the U. S. Office of Education, Federal Security Agency. Of the 50 reels of film comprising the program, 18 have been completed and are now being reproduced in 16mm size, according to Castle Films, Inc., which was awarded the contract for distribution.

"The U. S. Office of Education has produced a series of motion-picture films dealing with mechanical skills and knowledge, expressly designed to be used by vocational teachers and shop instructors," said Dr. John W. Studebaker, U S. Commissioner of Education, in describing the purpose of the films "These films will assist potential and employed defense workers more rapidly to learn and more thoroughly to comprehend the instruction being given them in the vocational schools throughout the United States."

Following a detailed course in the handling of machine tools in precision work, 40 of the films cover the subject of machine-shop practice Seven reels are devoted to the engine lathe, five to precision measurement, five to the vertical boring mill, five to the milling machine, five to the use of drill presses of various types, seven to bench work, three to the shaper, two to the action of single point cutting tools, and one to centering and layout Operations in ship building are covered by 10 more films, still in production

Slide-Binding

Color transparency slides may now be bound in about the same manner as prints are mounted in a dry-mounting press. A completely new departure in the field of slide-binding, the method is made possible by a vise-like affair containing a heating element The slide is inserted, as usual, in a paper mask called "a scientifically prepared thermo mask," and then between two pieces of 2 by 2-inch glass. The assembly is held together with a small clip, no tape or frames being used, and then fed between the flat jaws of the vise, the bottom surface of which is electrically heated. The jaws are slowly brought together and allowed to remain thus for about 30 seconds, at the end of which time they are separated by pushing down the lever and the slide is complete, firmly held together by the adhesive with which the mask is impregnated

No tape, no frames

Make 'Em Clown

Don't take on too serious an attitude when you're shooting a child's picture It scares the child into awkward, stiff poses and expressions, with the result that the pictures you get lack life and naturalness. Try making them clown, that is, let them mimic whatever or whoever they think is funny. Children have their own sense of humor, which adults often fail to appreciate But if you will try to put yourself in the child's place, forget that you're grown up, make believe you're a child again, you will see pictures even when the child clowns Some of them will be very bad; many will be very good because they are spontaneous and because the child is unconscious of the camera The boy in the illustration expressed a wish to wear glasses and imitate a grown-up The photographer complied and the subject was happy So is the result, we think

Smile, and subject smiles, too

Correction

In the item "Print Reducer" which appeared on page 208 of our April 1942 issue there was an error in the formula given Solution A of the reducer should consist of 200 grains of sublimated iodine and 10 ounces of alcohol, not 20 ounces of sublimated iodine and 10 ounces of alcohol as was originally stated in these columns.

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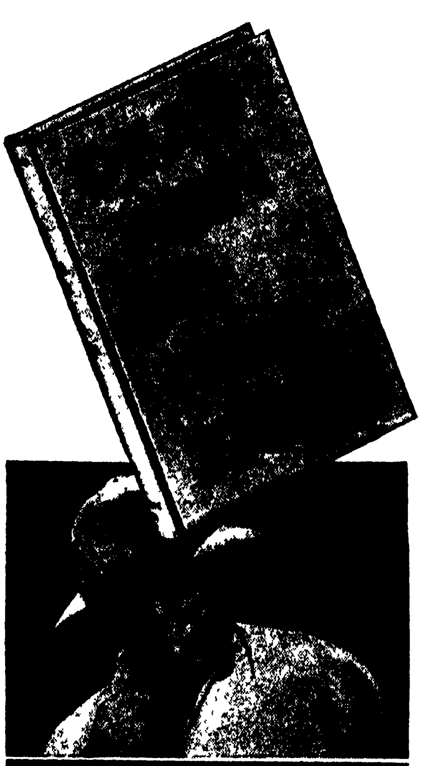

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By D. Hay Surgeoner

Although the text of the present book is prepared from the British viewpoint, the information presented is of such fundamental nature that a perusal of it will serve to give a satisfactory foundation for the average reader who wants to know a little more about the "why" of flight. The chapter titles indicate the scope of the work: The Atmosphere, Fluid Motion, Aerodynamics, Practical Considerations, Stability, Control, Airscrews. (108 pages, 5 by 7½ inches, a number of line drawings.)—$1.30 postpaid. —*A. P. P.*

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By John R. Roebuck and Henry C. Staehle

After an amateur photographer becomes thoroughly familiar with the operation of his equipment and has thoroughly grasped the technique of photography, he frequently wants to delve into the fundamental science of this subject It is for this ever-expanding group that this present book is intended. The text surveys the modern science of photography, presents a brief sketch of the historical developments, and then gives detailed attention to the properties of photographic materials, the factors determining correct exposure, and the sensitivity to color needed to preserve tonal values. This is followed by a consideration of the chemical processes of development and of the positive processes such as printing, enlarging, and making slides. A chapter is devoted to the latent image theory and another to lenses and the optical aspects of photography Color photography is fully discussed and a section of the book gives a concise presentation of the subject of composition and other aids in making good pictures. A "laboratory manual" presents a series of practical experiments. (283 pages, 6 by 8½ inches, 96 illustrations)—$5.10 postpaid *A. P. P.*

BOATBUILDING

By Howard I. Chapelle

So far as this reviewer can ascertain, this is the most complete book on boatbuilding It isn't for the greenhorn; the user should already know things about boats and tools. It was written in detail because the magazine articles usually skip the parts a designer and builder most needs to know. This book, by a well-known builder, is a practical shop book, no mere armchair companion It stresses especially mold loft work—laying out beforehand in full size—the lack of which so often lands landlubbers in jams. The craft employed as examples are all sailing craft, and many are Chesapeake Bay types, but the principles explained in so much detail are basic to all types. (624 pages, 6 by 9¼ inches, 186 illustrations)—$5.10 postpaid—*A. G. I.*

NOSTRADAMUS SEES ALL

By Andre Lamont

The author, born in the Orient, educated in Europe and America, known for his articles on astrology, the Kabbala, and various methods of reading character, utilized all available books on Nostradamus—many rare and in several languages—plus the Houdini collection, and other original source material to present this volume of interpretations of the prophecies by Nostradamus, the 16th Century astrologer. Also, a comprehensive and interesting biography of the medieval physician who foretold World War I, the rise of Communism, Fascism, Nazism; the emergence of Stalin, Mussolini, Hitler, Franco, Churchill, Roosevelt, Petain, and others. (341 pages, 5 by 7½ inches, illustrated.) $2.60 postpaid. —*A. D. R., Jr.*

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By Willis I. Milham

RE-ISSUE of a book dated 1923, now available at greatly lowered cost and, even today, out of date only in minor degree, but a book which still has no equal in the sense of its "all-aroundness." Author is Professor of Astronomy at Williams College and the subject is his scientific hobby. The book covers the whole field of the history, construction, care, and accuracy of clocks and watches, without assuming previous knowledge on the reader's part. Aspect most emphasized is the history of early clocks and watches. A book for other hobbyists (616 pages, 5½ by 8⅜ inches, 339 illustrations) $2.10 postpaid.—*A. G. I.*

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By Edwin Spencer Cowles, M.D.

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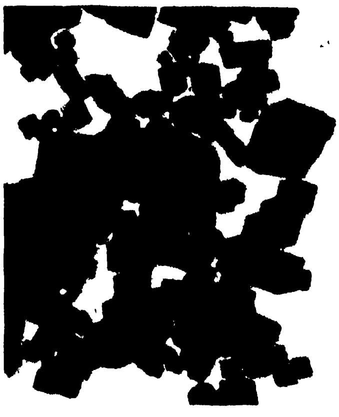

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Construction Glues is a large folder which presents, partly in question-and-answer form, pertinent facts regarding the use of glues in the building field—in prefabrication and in laminated arches and beams. A number of photographs show varied application. *I. F. Laucks, Inc., 911 Western Avenue, Maritime Building, Seattle, Washington.—Gratis.*

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The Care and Use of Electric Appliances in the Home is a 32-page indexed booklet which tells housewives how they can help in the present national emergency by the efficient use and proper care of their electrical apparatus. It also contains food buying and menu suggestions, as well as housework short cuts. *Westinghouse Appliance Dealers or direct from Westinghouse Electric and Manufacturing Company, 40 Wall Street, New York, New York.—Gratis.*

Handbook for Drillers is a 48-page illustrated manual prepared especially for students in war production work, yet of equal interest to anyone in any way concerned with modern and standard shop practice. It gives an introduction to the theory underlying the use of the twist drill and considerable data on speeds, feeds, and general operation. Exceptionally well illustrated. *The Cleveland Twist Drill Company, 1242 East 49th Street, Cleveland, Ohio.—Single copies gratis. Price on quantities on application.*

Ideal Quality Transmissions is a 52-page handbook which includes recommendations, application data, photos, and engineering information on variable speed pulleys and transmissions. The data presented are of interest to design engineers, mechanics, purchasing agents, and so on. *Ideal Commutator Dresser Company, Sycamore, Illinois.—Gratis.*

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and "Amateur Telescope Making—Advanced"

In his astronomical article, page 230, Professor Russell states that the principal instrument possessed by the newly inaugurated Mexican National Observatory is a Schmidt camera of 24" effective aperture, and he stresses its great value to astronomy. Amateur telescope makers are also keenly interested in the constructional side of any such instrument, and the Perkin-Elmer Corporation, now in a bright and shining, newly-built plant at Glenbrook, Connecticut, was therefore invited to submit a brief note for these pages. The note:

"When the Mexican Government contracted with the Perkin-Elmer Corporation for a large Schmidt camera, the aperture was specified as 24". The very outermost zones of a corrector plate, however, do not come to proper curve by the treatment which is best for the inner zones. In the case of a 24" Schmidt previously made by this company for the Harvard College Observatory, the plate was not oversized, and consequently the edge zones delayed the final figure. For the Mexican instrument, therefore, Halley Mogey, Chief Optician, requested a larger blank, so that the 24" clear aperture could be obtained in the least time. The grinding and edging operations were directed by T. J. La Lime, head of the grinding department.

"Although the curve on this corrector plate is imperceptible to the eye (the focal ratio is $f/3.5$), the difference between it and a perfectly flat plate is an amount of glass as big as a lump of sugar (about a quarter of a cubic inch) all removed by polishing alone.

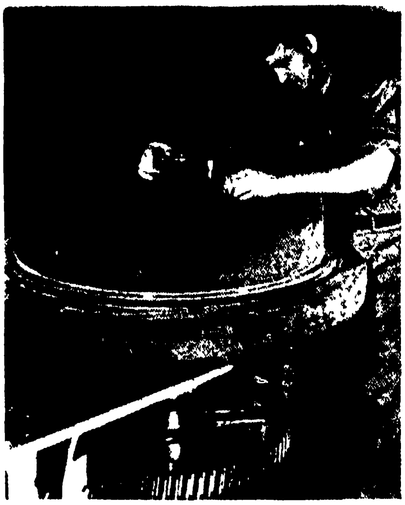


Figure 2: La Lime and 31" mirror

"Both the knife-edge and the Ronchi grating were used in the test set-up, which involved auto-collimation from a flat mirror and the use of a small periscope for looking at the image without obscuring much of the beam. When the mirror and plate were completed, no errors at all could be seen under this test over at least a 24½" aperture."

The three shop photographs, Figures 1, 2, and 3, were furnished at our request by Richard Perkin. They were taken by the former amateur telescope maker, Robert E. Cox, who a year or two ago "went professional" with the Perkin-Elmer Corporation; another former amateur employed there being Daniel E. McGuire who similarly went professional several years ago. Amateurs are now in so many professional optical shops that this department finds it almost impossible to draw a line between the two. There actually is no such line; it has been washed out. Most of the professionals were amateurs at one time.

Figure 1 shows the 31" Schmidt mirror disk in the last stage of emery before polishing. The machine itself will also interest our readers. So will chief optician Halley Mogey, who stands beside it. (Some day this department may publish a series of personality articles on prominent people in professional optics.) Your scribe believes Halley Mogey's name never is mentioned without the inevitable after-question, "Was he named for Halley's Comet?" Halley Mogey really *was* named for Halley's Comet. What was more logical—his father a telescope maker and the two arrivals coinciding? The boy grew up in his father's shop at Plainfield, N. J. (now run by another son, William Mogey, assisted by Messrs Brown, Lojas, and Grosswendt, all former amateurs). There he gained the "feel" of glass and abrasive. Then he went off to college and gained theory, and returned equipped on both sides, practical and theoretical, to make maximum application of the mind-and-hand team. When Schmidts came along, a few years ago, he went to the Mt. Wilson optical shops to learn special Schmidt technique; and left there some of his own. In Figure 1 he is seen in shop clothes. A good optician, no manner how much theory he has in his head, never is too lofty to get into working pants and use his hands.

Figure 3: Mogey's expert digit

Figure 2 shows the same 31" disk fine-ground, with T. J. La Lime, head of the grinding department, measuring the radius of curvature with a spherometer.

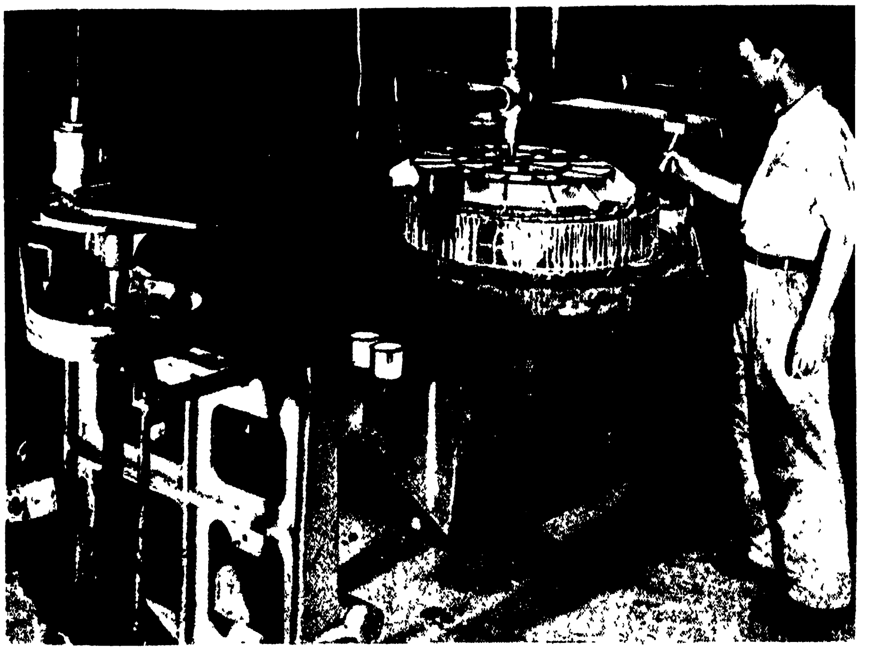


Figure 1: Machine, mirror, Mogey

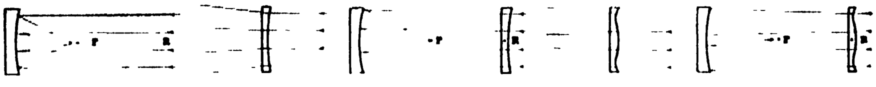


Figure 4 (right): Schmidt evolution

In Figure 3, Halley Mogey is hand-touching an outer zone on the 26" corrector plate of the Schmidt camera. Some years ago amateurs argued whether the tradition that the old-time professionals used their hands as a "rubber" (as non-telescope making persons styled it) for local touching, was true or just a story. While some argued, others tried it, and it worked. Since then it has been amply proved by other evidences that the old-timers did use this method, the popular tradition was quite correct. Besides, the method is not in any way remarkable; simply, instead of a small tool of pitch, a small tool of fine leather is used—that is, the hand or whatever part of the hand is the user's own pet method. In Figure 3 you see this method in the flesh. This photograph, now published, will be useful to show to occasional doubters about hand touching among professionals.

No clearer, simpler, more direct explanation of the working principle of the Schmidt camera has been seen by this department than one found in a booklet describing the newly added equipment at the Warner and Swasey Observatory of the Case School of Applied Science at Cleveland. The drawings from the booklet are reproduced in Figure 4, and here is the explanation.

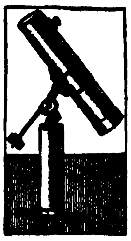
"In 1931 Bernhart Schmidt, an optical worker at the Hamburg Observatory in Bergedorf, published an account of a reflecting telescope free from nearly all the inherent defects common to such instruments. This was accomplished by introducing a thin lens in front of a spherical mirror.

"His reasoning was clear and logical in spite of the fact that he avoided all mathematics. He ended his article by stating 'The method of producing the lens is assumed.' In other words, he was not going to reveal the secret, a characteristic common to optical workers, particularly of the past.

"It seems that the first Schmidt telescope was completed in the summer of 1930, when Schmidt and a friend amused themselves by reading the epitaphs on the tombstones in a nearby cemetery. A remarkably detailed photograph of a windmill a mile and a quarter away, made with his first telescope during a moonless night, is now of historic interest.

"In 1936, Dr R. Schorr of Hamburg Observatory finally disclosed the secret of how Schmidt, who had died in 1935, had produced the surface of the all-important lens. Schmidt placed a plane-parallel disk of glass on the open end of a circular cylinder of nearly the same diameter and evacuated the cylinder until the desired bending of the glass disk was secured. Then he polished the glass disk surface to a perfect plane. After allowing the air to re-fill the cylinder, the plane polished surface took the desired form of the lens.

"The Schmidt-type telescope employs a spherical mirror instead of the usual parabolic mirror of the reflector. Parallel rays incident upon a spherical mirror do not come to a focus at the same point. The rays striking the center of the mirror come to a focus at a point *F*, midway between the mirror and its center of curvature, while rays striking the outer zones come to a focus somewhat nearer to the mirror.



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"If, however, we make the light striking this outer zone slightly divergent, all the rays can be brought to a focus at *F*. This is accomplished by placing a thin lens in front of the mirror and at its center of curvature. The shape of such a lens is shown in the second diagram.

"This results in the combination in the third diagram.

"The same results may be accomplished by introducing at *R* a lens with a shape shown in the fourth diagram.

"In this case, the outer rays are less divergent and the center rays slightly convergent. The resulting combination, with the focus now a little closer to the mirror, is shown in the final diagram.

"If the parallel rays are directed to the telescope from an angle different from the one shown in the above figures, they will again come to an exact focus. This is due to the fact that the mirror is spherical and has no axis, and the lens is at the center of curvature of the mirror. The optical system thus remains exactly the same as before.

"The bundles of parallel rays striking the mirror from all angles will thus be focused on a photographic plate bent into a slightly spherical surface. In practice it is easy to bend ordinary flat photographic plates into the necessary spherical form.

"Stated in another way—rays of light entering the telescope from stars widely separated in the sky will be brought to an exact focus; a condition not realized in the usual reflecting telescope. Thus a large area of the sky may be photographed at one time.

"Since the lens employed is relatively thin, it produces an instrument which is free from the color defects associated with refracting telescopes. Also, since the focal ratio of the telescope can be made small without sacrificing other desirable properties, the instrument is 'fast' in the same sense as the word is used with respect to cameras.

"The wide-angle field, the achromatic properties, and the speed, are the three principal advantages of the Schmidt telescope."

The new Schmidt camera at the Warner and Swasey Observatory has a 36" Pyrex mirror of 14' radius of curvature, with a 24" lens of Vita-glass, .3" thick. Maximum departure from a plane is .0005" and the optical work was done by C. A. Lundin of the Warner and Swasey Co., Cleveland, Ohio.

Before the beginner has picked up from here and there a modicum of general background about telescope principles he is almost sure to run up at least one blind alley in pursuit of a beautiful illusion. Your scribe, for example, in 1924, when quite innocent of telescoptical background, saw a picture of a group of reflectors made by the Telescope Makers of Springfield, Vermont. One of them was short, chubby, compact, unlike the others. Obviously that one would be *much* better, hence the one to make. Now it happens that a short chubby telescope (short focal ratio) is an ideal one for the tyro not to make, because the curve of the mirror is much more difficult when deep—more advanced work. Russell Porter explained this fact and your scribe desisted.

On the opposite extreme are telescopes having great length—long focal ratio—and when the tyro discovers that these give high magnification he is inclined to plump for one as his first job. These, however, are a headache in other ways. As John Pierce puts it: "Made a 4" of 90" focal length with very poor results so far as comfort in observing goes—hard to point—diagonal large and field necessarily small, since the large-lens eyepieces are not available."

Commenting on a tyro's proposal to make a "high-magnification" telescope with focal ratio 40, Alan R. Kirkham made apposite observations in an old letter dug up by your scribe from the lower, or pre-Cambrian, strata of his desk (had a housecleaning):

"Focal ratios of longer than *f*/20, which itself is extreme, cannot be recommended because they do not give full fields with any but eyepieces whose magnifying power is above most practicable limits. The focal image of the Moon in a telescope of 6" aperture and focal ratio of 40 is big—about 2.088" in diameter—it is true. However, compare the size of the field lens of a 1" eyepiece with this and see how miserably small the field actually seen will be. In order to get down within the magnifying power universally agreed to be best for seeing, about 16 diameters to the inch, or perhaps 10 to 20 diameters depending on various factors, we require a 2½" eyepiece with such a telescope. Good eyepieces are easily designed for a useful field of 40°, but the ability to give this apparent range depends on the field lens being large enough to receive all the rays of 40° magnification. The condition is met with in all eyepieces of about 1¼" focus, down. A 1½" eyepiece needs a field lens 1⅛" in diameter, a 2" eyepiece one of 1½" diameter, and a 2½" should have a field lens about 2" in diameter. These 'out' sizes are hard or impossible to find—it's about like asking for a size 22 shoe at a shoe store. In a nutshell, we get only a narrow field, caused by the telescope itself having wrong proportions. Moreover, these eyepieces would have great spherical aberration. They also require several inches of rack and pinion work for focusing from the longest to the shortest of them, and require diagonals of too great size. They also suffer from curvature of field.

"If that is not enough, there are other reasons why the existing range of eyepieces became more or less standard—for it didn't just 'happen.' The long focal ratio takes a very long and awkward tube, and this means trouble in keeping the optical elements in alinement. Besides, try figuring an *f*/40 mirror—I did. Just like looking at the head of a pin. Diffraction effects are very great, and the mirror even seems to move around with the motion of the eye. In focograms, such mirrors are surrounded by a diffraction edge half the radius of the mirror itself. Finally, the image is poorly illuminated."

Persons who urge the beginner to adopt conventional designs in anything, just because these designs are conventional are, of course, simply gratuitous irritants; but on the other hand there often—though not always—is some sound reason behind a convention, representing the experience of those who came before.

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PROGRESS in the chemical industry, dealt with in detail on page 278, is symbolized by our front cover photograph, taken in a plant of the Calco Chemical Division, American Cyanamid Company, of one part of a process of producing organic chemicals.

●

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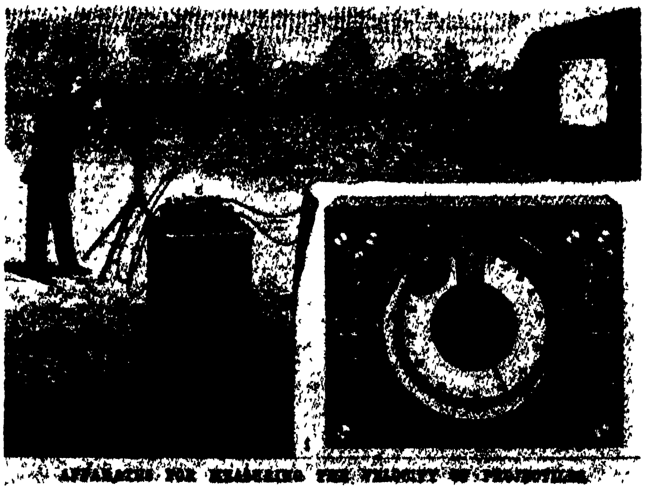
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of June, 1892)

COLOR PHOTOGRAPHY—"The method adopted by Mr. Ives for photographing in colors is another instance of American ingenuity. Acting on Helmholtz's theory that the nerves of the eye respond to wave vibrations corresponding to light of red, green, and bluish violet, and that all tints are made up of combinations of these light waves, he takes three photographs of a scene or object, screening off from the first sensitized plate all but the red rays, from the second all but the green rays, and from the third all but the blue-violet rays. Then he places the photographs on celluloid in a three-lens lantern, and projects these so that they coincide in one picture, screening his lenses with glass of red, green, and blue-violet color. The result is a large photograph in all the actual colors of nature."

CHRONOGRAPH—"The chronograph of Mr. Schmidt, which is capable of measuring as minute a period of time as the ten-thousandth part of a second, is based on this principle: The regularity and rapidity of the movement of the balance wheel of the escapement enables measurement to be made of intervals of time much less than that of one oscillation. . . . These chronographs have been used principally for measuring the initial speed of projectiles. At the moment of discharge the projectile breaks the current by cutting a wire which is stretched in a primary frame attached to the end of the gun. The chronograph continues to operate until the projectile passes through a secondary frame located in front of the target . . . It is possible, therefore, to read the exact interval that has elapsed while the projectile has passed between the two screens."



APPARATUS FOR MEASURING THE VELOCITY OF PROJECTILES

ENGINES—"A 60 horse power nominal Otto gas engine is one of the largest gas engines yet constructed. Even when the success of the Otto gas engine of sizes up to 20 indicated horse power had been insured a few years ago, the makers themselves would scarcely have ventured to predict that in the short time that has since elapsed engines indicating 85 horse power with a single cylinder would be commercially successful, and supplanting fairly good steam engines."

MOUNTAIN RAILWAY—"The most recently completed high mountain railway in Switzerland is that up the Rothhorn 7,240 feet high, from the lake and town of Brienz, not far from Interlaken. . . . The material through which the eleven tunnels of this line were excavated consisted of debris which had slipped down the mountain, and which seemed disposed to go on sliding when disturbed. Subterranean springs also made the work difficult, and in places new beds had to be made for mountain streams."

BANANAS—"While apples yield only 12 per cent, bananas with the skins removed yield 25 per cent of thoroughly dessicated fruit The supply of bananas is practically unlimited. The fruit grows to maturity all the year round, and may be obtained every day throughout the year, so that the manufacture of dried bananas can be made continuous."

MOSQUITOES—"The beak of the mosquito is simply a tool box, wherein the mosquito keeps six miniature surgical instruments in perfect working order Two of these instruments are exact counterparts of the surgeon's lance, one is a spear with a double-barbed head, the fourth is a needle of exquisite fineness, a saw and a pump going to make up the complement."

CANAL TRAFFIC—"Few persons who have not made a personal study of the matter realize the magnitude of the traffic of the Great Lakes. There were over 1,100 more vessels passing through the canal into Duluth, Minnesota, in 1891, than passed through the Suez Canal the year previous. Through the 'Soo' Canal at the outlet of Lake Superior there were more than three times as many vessels and nearly a million and three-quarters tons more freight in 1890 than through the Suez Canal during the same year."

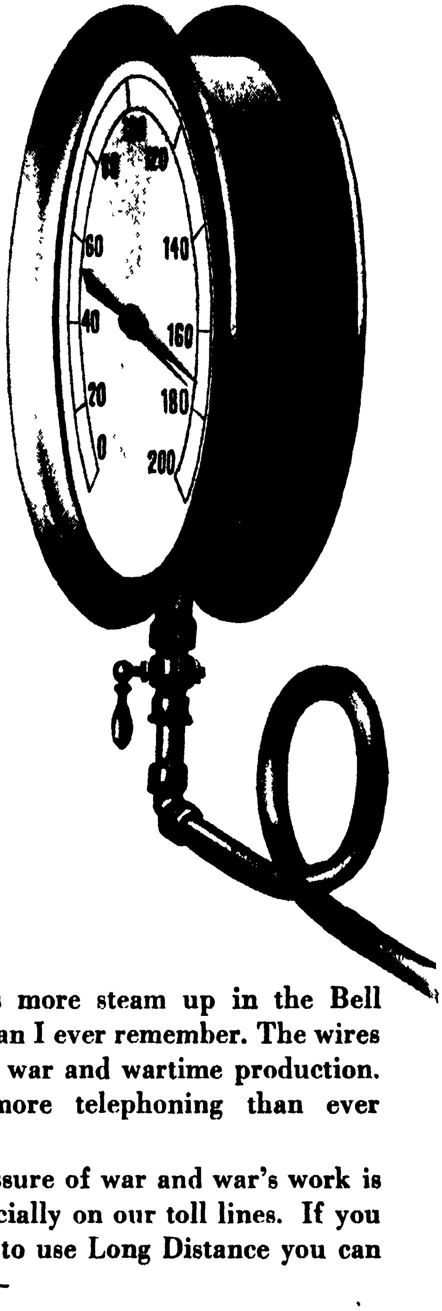
BOMBING—"Mr. Maxim, of gun fame, has for some years directed his attention to the problem of aerial navigation. Recently he said· 'If I can rise from the coast of France, sail through the air across the Channel, and drop half a ton of nitroglycerine upon an English city, I can revolutionize the world. I believe I can do it if I live long enough. If I die, some one will come after me who will be successful. if I fail It can be done as sure as fate'"

FAMINE—"The attention of the whole world is directed to the terrible famine in Russia; consequently it is not generally known that a similar scourge is afflicting India. In this country all the horrors which follow in the wake of starvation occur with fearful regularity every fifteen years, or twice in every generation. The last great famine was in 1876."

SLUMBER—"It is said by scientists to be a fact that all our senses do not slumber simultaneously, but that they fall into a happy state of insensibility one after another. The eyelids take the lead and obscure sight, the sense of taste is the next to lose its susceptibility, then follow smelling, hearing, and touch; the last named being the lightest sleeper and most easily aroused."

PASTEURIZATION—"Machines are in use in Paris and some other cities which will heat great quantities of milk to a temperature of about 155°Fah. for a few minutes, and then cool it rapidly to a low temperature. The method has been called the pasteurization of milk. It does not kill all the bacteria, but it does destroy so many of them that it greatly increases the keeping properties of the milk. Moreover, it almost entirely destroys the danger from disease germs in milk, since nearly all forms likely to occur in milk are killed by this temperature."

"Carrying lots of pressure these days..."



"There is more steam up in the Bell System than I ever remember. The wires hum with war and wartime production. There's more telephoning than ever before.

"The pressure of war and war's work is on—especially on our toll lines. If you are going to use Long Distance you can help by —

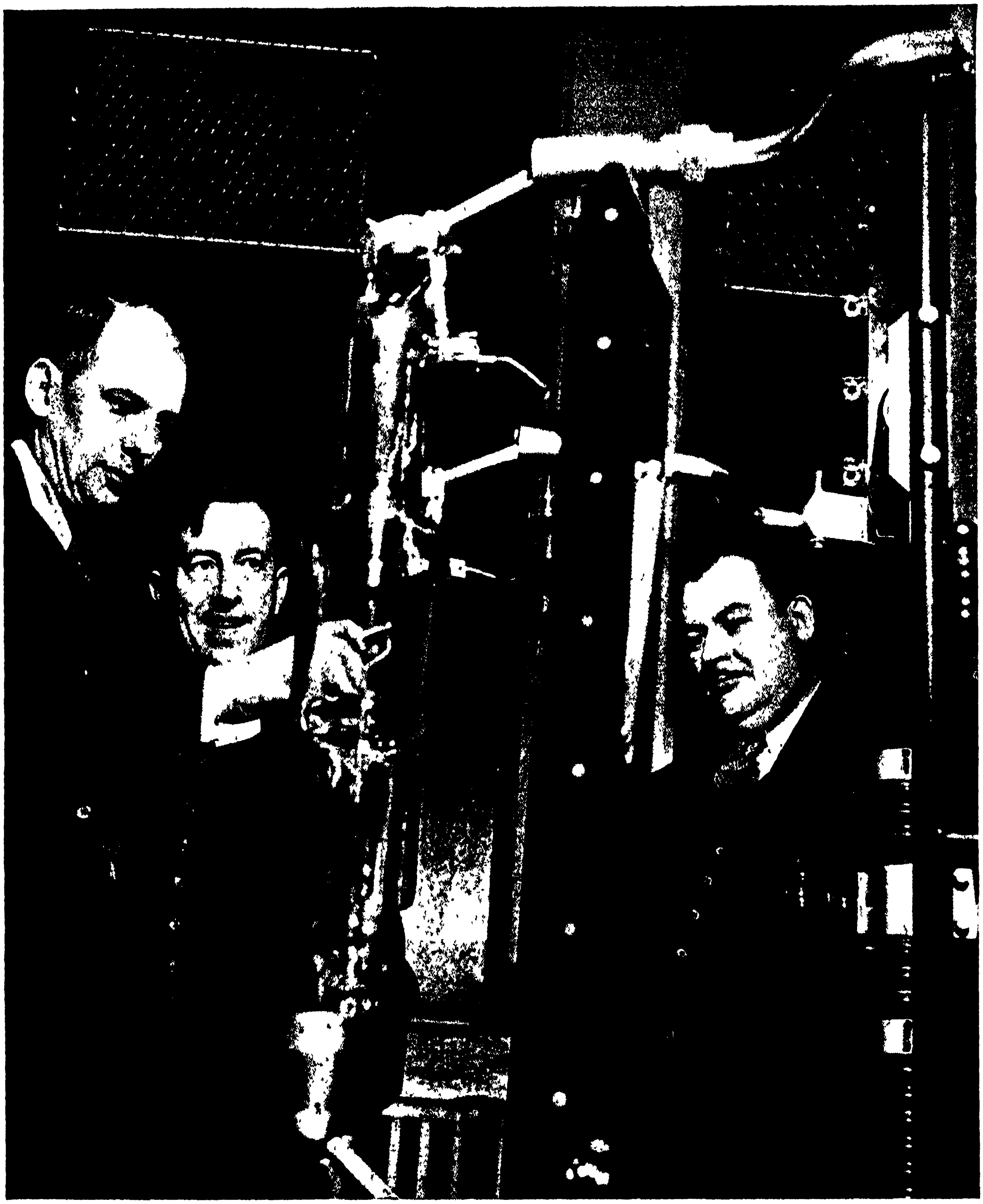
Knowing the number you want to call.

Calling in the less busy hours — before 10 A. M. and after 8 P. M., for example.

"Let's give vital war calls the right of way and make equipment go as far as possible, saving copper and other materials for the war."

BELL TELEPHONE SYSTEM

"The Telephone Hour"— *presenting great artists every Monday evening — N.B.C. Red Network*



X-RAY PHOTOGRAPHS IN A MILLIONTH OF A SECOND

High-speed photography, by X-rays, of bullets passing through gun barrels or smashing their way through armor plate are possible with the new X-ray tube invented by Dr. C. M. Slack (left, above), of the Westinghouse Lamp Division laboratories. Dr. Slack is shown explaining a laboratory model of the tube to Dr. Herschel Smith, civilian aide at Frankford Arsenal. At right is L. F. Ehrke, who collaborated with Dr. Slack in the development of the tube. More details of the tube and its uses will be found on page 293.

98TH YEAR SCIENTIFIC AMERICAN JUNE 1942

'POP-GAS' AIDS WAR DRIVE

Harmless Vapor Balks Saboteurs, Saves War Plants

PAUL W. EBERHARDT

SOMEWHERE in New Jersey several hundred men are working day and night turning out steel cylinders, filling them with common ordinary "soda-pop" gas.

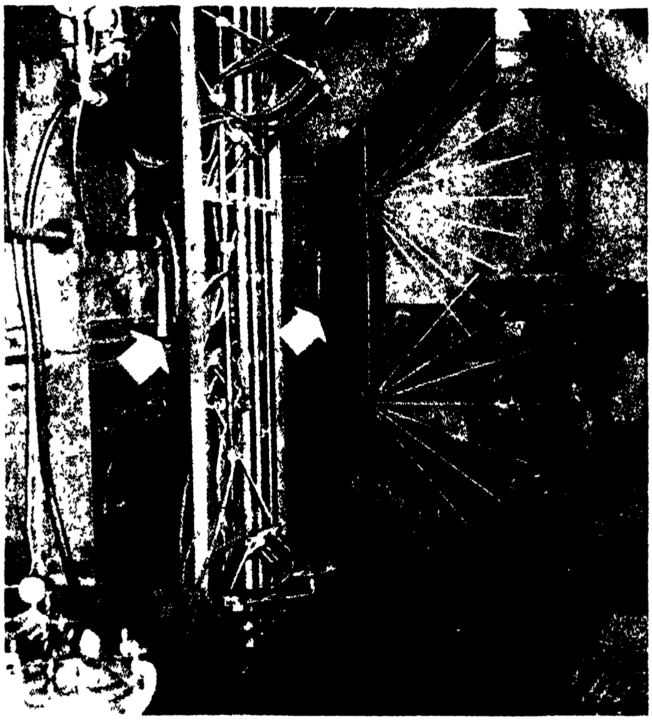
Somewhere in Connecticut an airplane engine is taking a final test. A defective fuel line spills raw gasoline on a red-hot steam pipe. Instantly the supply trench under the test cells is a river of flame, but the motor is delivered on schedule.

Somewhere in California a saboteur places an incendiary tube in a storeroom stacked with drums of flammable liquids, but the fire department isn't even called. Damage is negligible.

Somewhere in Tennessee a huge generator is supplying thousands of kilowatts of electricity for the manufacture of aluminum. A piece of insulation cracks and flame bursts out, but the faulty insulation is soon replaced and the generator is back on the job.

Somewhere in Alabama a plant is ginning cotton for Army duck. A piece of tramp iron causes a spark, ignites the lint in a flue, but 15 minutes later the gin is back in operation.

From all over the country come reports of fires that threaten great industrial plants, power companies, refineries, and warehouses, fires which threaten total destruction but which are miraculously snuffed out with little or no damage. How do these seeming miracles take place? The answer is in the cylinders being turned out by those men in New Jersey and the "soda-pop" gas with which they are filled. For it is this gas that snuffed the flames at their inception—turned a possible holocaust into just a minor accident.


Carbon dioxide protects airplane engines under test. Arrows point to discharge nozzles; white lines at right indicate extra gas from special screening nozzles

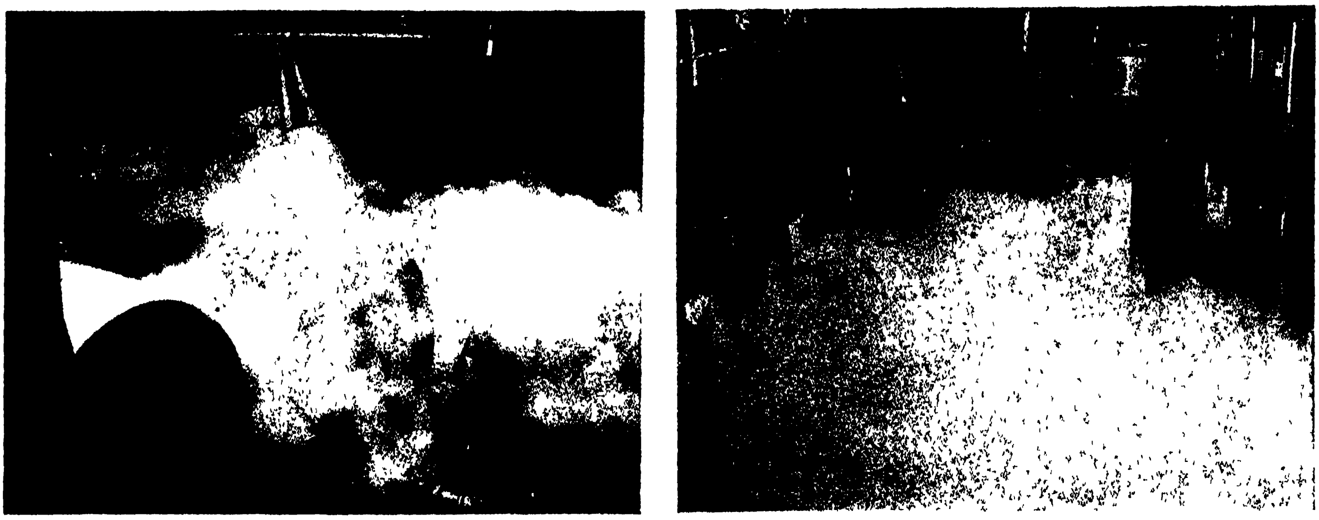
Legend has it that carbon dioxide's peculiar ability to smother fire was discovered accidentally by a Swedish harbor-master who was using the compressed gas to make a light-buoy wink at regular intervals. One night his supposedly non-extinguishable flame went out, and investigation proved leaking carbon dioxide gas to be the cause. Be that as it may, American engineers get the bulk of the credit for harnessing the gas and teaching it new tricks, for a great many harnessing stunts began on drawing boards in the New Jersey laboratories of Walter Kidde and Company.

Carbon dioxide's debut as a fire-extinguisher took place soon after the World War I—on the high seas. The then-untried gas was introduced dramatically to London ship-owners by an engineer, who rented an old trawler, set a raging gasoline fire in its hold, and extinguished the blaze in a matter of seconds with clouds of the cold, white gas. Since that demonstration, carbon dioxide fire protection devices have become standard equipment on merchant vessels. It is even being used on the new Liberty ships which have been stripped of all non-essentials.

Just how does carbon dioxide work on a fire? As any physics student knows, air at sea-level contains 21 percent oxygen. If that oxygen content is substantially reduced, a fire cannot burn. So if enough carbon dioxide is discharged over the flames to cut the oxygen content to 14 or 15 percent, the fire goes out.

This same principle is applied in fighting sea fires. Stored carbon dioxide is discharged into burning cargo compartments, inaccessible to ordinary fire-fighting agents. The white gas penetrates into crevices and underneath bales where fire may be burning, instantly extinguishing all flame. There has been no change in this basic principle since the initial application of the gas to cargo fires. The major improvements have been made in the means of distributing and discharging the gas, and of detecting the fires to be extinguished.

Detecting the presence of cargo fires is as important as extinguishing them, and the old method of having the deck officer sniff at ventilation tubes was



A storage room packed with inflammable materials is protected against fire by a carbon dioxide system. At left, gas is being discharged to cover the whole room as at right. A few seconds later, room was flooded to ceiling

long ago found far too haphazard. The engineers solved this problem by developing an automatic sniffer which employed an electric eye to investigate air samples drawn automatically, every few seconds, day and night, from each cargo hold. These same "sniff pipes" are the pipes through which the blast of carbon dioxide is directed into the cargo hold, once a trace of fire is detected.

But the Kidde engineers did not stop with perfection of this gas for sea-going duties. While one group of engineers worked on the automatic sniffer and similar maritime devices, another group tackled the even larger problem of industrial fire protection. It is to the result of their labors that the airplane engine in Connecticut, the storeroom in California, the generator in Tennessee, and the cotton gin in Alabama all owe their escape from a flaming end.

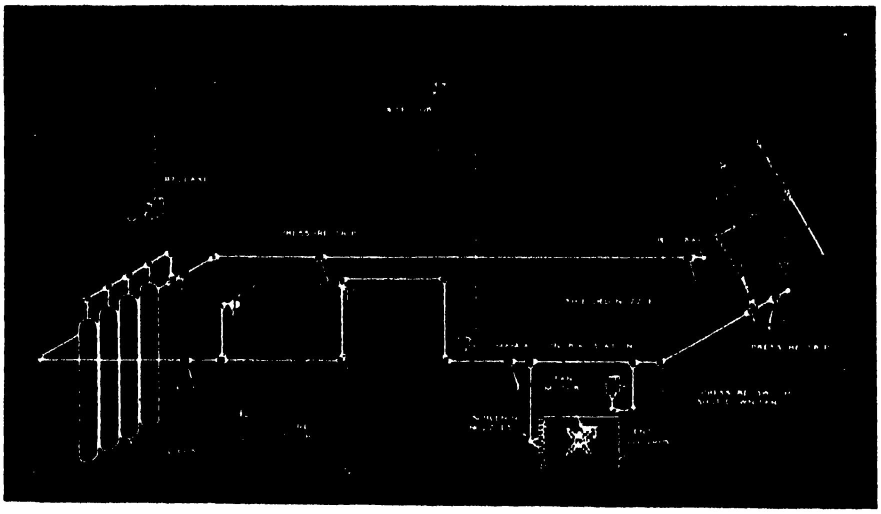
A small cylinder of carbon dioxide supplies buoyancy for life vest

The importance of carbon dioxide industrially comes from the fact that it is especially effective against two types of blaze—Class "B" (flammable liquids) and Class "C" (electrical equipment). For these two hazards account for a large percentage of today's factory fires. What's more, in many of these fires carbon dioxide is the only means of effective control.

For example, let's go back to that test cell in Connecticut and see exactly what happened. As soon as the gasoline ignited, the fire registered on a heat-sensitive detector in the fuel-supply trench. This detector opened the valves of a bank of steel cylinders located outside the threatened area. Carbon dioxide gas, stored in these cylinders at a pressure of 850 pounds per square inch, roared through pipes into the trench, expanding to 450 times its stored volume, and completely flooding the burning space. In a matter of seconds the flames were completely stifled. And after the fire was out, the extinguishing gas dissipated in a few minutes, leaving no residue.

In California, the saboteur had counted on three things—surprise, inaccessibility of the crowded storeroom, and a blaze of such intensity that no human would dare face it. But a carbon dioxide system cannot be taken by surprise. Its heat sensitive detectors were on guard every second of the day and night. Likewise, inaccessibility was no problem, as the system flooded every cubic inch, every niche and crevice of the room, with the heavy, white gas. And of course the human element was not involved, as the whole situation was handled by steel cylinders, steel pipes, and an inert gas which not only flooded the room and put out the fire but, in addition, released trips as it rushed through the pipes, automatically closing doors and windows through which the flames might have spread into other parts of the factory.

THE equally important role of gas extinguishing in electrical fires is shown by the generator in Tennessee.



Diagrammatic layout for a typical industrial system for flooding a room with carbon dioxide gas. Pressure trips are used to close doors and windows

As in the previous cases the system was entirely automatic. At the first trace of smoke the generator housing was completely flooded with gas—an action which could be taken without the slightest worry of short circuits and other electrical damage because carbon dioxide is a non-conductor. At the same time, a second bank of cylinders was held in reserve to discharge its contents gradually into the housing and maintain the concentration of gas during the half hour needed to stop the huge rotors. This added precaution did away with any possibility of re-ignition and, since the gas could be dissipated with a few moments ventilation, there was no fear of damage from the extinguishing agent.

The story of the Alabama cotton gin is similar, but it is notable in this case that carbon dioxide does a twofold job. It not only stifles the immediate blaze, but it is equally efficient in guarding against partially ignited fibers which, if not quenched in the flue, may find their way into the center of a bale and smoulder, later causing a disaster on a dock or aboard ship.

While the above examples are all concerned with automatic systems, some built-in carbon dioxide equipment is operated by manual control. In such cases, however, the control is located at a distance from the fire hazard so that there can be no question of the flames preventing workmen from reaching it.

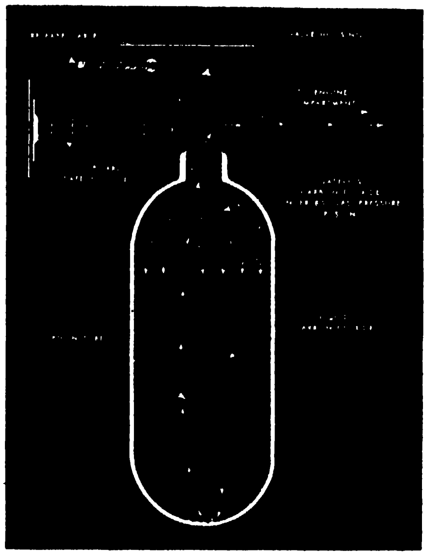


Diagram of extinguisher, hand controlled, for 'plane installation

Still another milestone in the saga of this modern fire-eater was the portable carbon dioxide extinguisher. The impetus to create such a device came first from the telephone companies, who yearned for a fast method of killing switchboard fires—a method which would not saturate or dissolve insulation. The pop-gas filled the bill, but the large steel cylinders then in use for carbon dioxide fixed installations were far too heavy for hand maneuvering. As a result, engineers developed a new light-weight cylinder, which now is not only the basis of the portable extinguishers found in homes and factories throughout the country but, in addition, protects military planes, tanks, and PT boats from fire during action.

But fire-fighting is not the only use to which Kidde engineers have harnessed soda-pop fizz. Among recent developments are collapsible life-belts and life-rafts that can be stored in a small place and given immediate buoyancy by releasing a shot of compressed carbon dioxide. Before the war they even had automatic waterwings for landplanes, which inflated as soon as the plane hit the water and kept it afloat. But these have been discontinued for the duration, lest forced-down ships, floating in war-zone waters, might fall into the hands of the enemy

• • •

PLANE DETECTOR

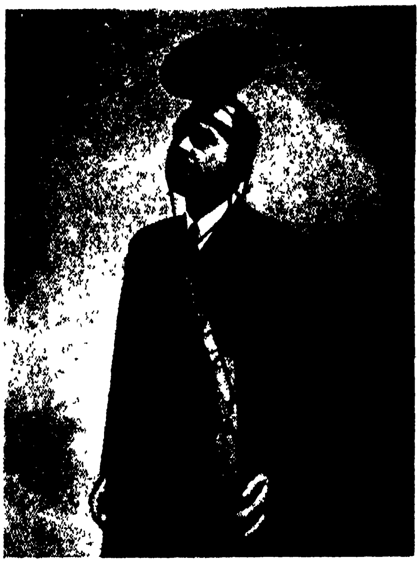
Portable, for Use by Plane Spotters

An aural plane detector, easily carried and operated by one man, has been developed by The Zadig Patents, for use by individual spotters of the Aircraft Warning Service. The accessories for the device, including the power supply, are housed in a case smaller than the familiar gas mask container.

When the device is to be used, the spotter puts on a headpiece suggestive of the Buck Rogers fantasies, consisting of earphones topped by a parabolic "concentrator" of sound waves, from which wires are plugged into an amplifying apparatus in the case. When a low-pitched sound in the earphones heralds the approach of a plane, the spotter turns his body until the sound is at its loudest. He is then facing the oncoming plane and is able to turn his binoculars swiftly and accurately on the aircraft to be identified.

It is claimed that the device has been passed upon by technicians of the U. S. Army Signal Corps and by members of the Aircraft Warning Service, who find that it can be used effectively by technically untrained spotters.

The pick-up unit is of thermoplastic material molded to a parabolic curve with a microphone of special characteristics placed at the focal point. The headband which carries the earphones also supports the concentrator.



Microphone in headpiece, vacuum-tube amplifier in case at side

The amplifier and its batteries are contained in a shielded drawer which slides into a compartment at the bottom of the carrying case. The amplifier uses three tubes of the miniature type which are connected in a high-gain circuit. Filters eliminate noises other than those emanating from the approaching plane. A volume control knob regulates the sound in the earphones to the watcher's comfort

BLACKOUT BULBS

Now Emit Deep Orange Light

Important changes in specifications for blackout bulbs recently described in these columns are announced by the Wabash Appliance Corporation, whose silver-lined bulb placed on the market in early January had been put through exhaustive blackout tests in actual city-wide blackouts in many states. Specification changes are based on the results of these tests, as well as on various official recommendations.

The most important specification change is in color of light from blue and red to the deep orange recommended by the office of Civilian Defense. Other changes are in size which is smaller, in reduced current consumption to 15 watts, in elimination of the former built-in reflector, and in an improved type of heavy black silicate coating to prevent light leakage.

The deep orange light that the new unit provides is said to be ample to permit room occupants to see each other plainly, as well as furniture, doors, and windows.

Cement Aids Oil Production

Deep Oil Wells are Controlled and Conserved by Application of High-Speed Cementing Process

ANDREW R. BOONE

THREE compound steam engines mounted on a large truck ceased their laboring. Standing alongside the outfit, Bert Fry wrung a muddy mixture of cement and perspiration from his shirt. A. W. Earl, who had been riding herd on the throbbing engines, closed a pair of control wheels, and Aaron Griffin, trailer tender, moved a horn-like chute to one side

"Well, boys," Bert grinned, "that does it. Dust fills the hole."

It wasn't really dust, and the hole no longer was a hole. Fry and his crew in 45 minutes had forced 75 tons of fast-setting cement, a special oil-well formula they had mixed with 20,000 gallons of water, down a pipe 11,200 feet long, out the bottom, and up a distance of a mile between the pipe and the rocky wall.

Cement in an oil well performs several important jobs. It prevents water from trickling down into the oil sand from upper formations, protects the casing against collapse due to high pressures in the earth, halts corrosion caused by highly mineralized fluids seeping through the formation, keeps gas from blowing out, and conserves shallow oil formations for future use.

When a drilling crew is ready for cement, they must have it fast, for oil wells have a way of running wild, perhaps bringing in water which ruins their production. It was to meet this need of urgent haste that Earl Halliburton, Los Angeles oil man, devised a system of speedy transportation of large quantities of cement and delivering it in a steady stream to the bottom of the deepest holes in jig time.

Alongside Highway 99, seven miles north of Bakersfield, California, stands one of Halliburton's groups of silos, from which the writer recently accompanied the crew on a cementing job.

This structure, though complicated in appearance, is much like a single silo of the type found on farms. It contains six cement bins, their mouths standing 15 feet up from the ground. Loaded by means of screw conveyors, each contains 55 tons of cement. When a cementing job comes along, a Diesel-engine truck-trailer pulls under the bins, a workman trips a lever, and the stuff pours down through a cloth chute into the huge trailer. When full, a batcher scale automatically weighs the load, and the driver roars off toward the oil field at a 30-mile-an-hour clip.

On arriving at the well, the trailers are backed in a semi-circle against another truck equipped with the three steam-operated pumps. On signal from the tool pusher, four members of the cementing crew swing into action, timing their actions to a split second.

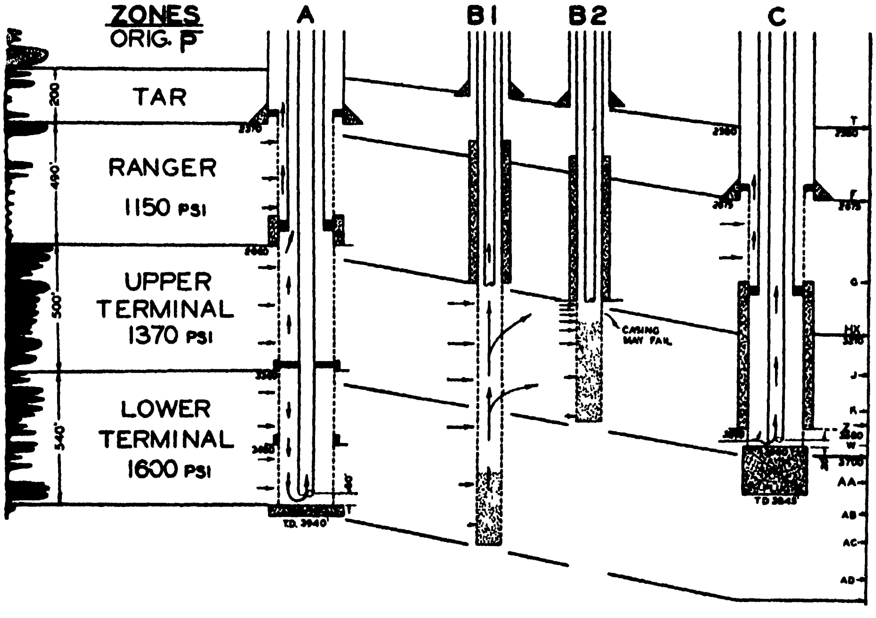
On the front of the first trailer to be unloaded, the driver starts a 16-horse power air-cooled gasoline engine. At the rear, another workman actuates a clutch, engaging the engine with a screw turning at the bottom of a double Vee running the length of the trailer. As the screw begins delivering cement into a cone leading through a small pipe to a slurry box alongside the pumper, still another workman turns on the water. And on the pumper, the fourth man opens a pair of valves, and the pumps start the thin mixture of finely-ground cement and water on its downward journey.

Until recently, a crew of 50 men was required to slit sacks and deliver cement into a mixer. Now four men do the job twice as fast. As the mixture leaves the pumps under pressure of 6500 pounds per square inch, it flows down inside the pipe, forcing ahead and out through the bottom, immediately above the oil sand soon to be brought into production, the mud used to lubricate the drill and pipe. Wood-and-rubber plugs and an expanding basket make it possible to keep mud and cement separated, and to place the cement exactly where it will do the most good. The basket, whose ribs are collapsed as it slides down the hole, lands on top of the oil-bearing sand. There the ribs expand, diverting the cement outward and upward.

MANY oil wells brought into production at great depths would not be flowing today, providing fuel necessary to keep the nation's war machine running, were it not for fast and accurate cementing. Unlike the cement that goes into concrete for pavements and sidewalks, this material is ground so fine that, at a depth of 2000 feet, it will set in an hour; in a 13,000-foot well, under great pressure and at temperatures high enough to produce steam, a hundred tons of the stuff, rising 6000 feet outside the pipe, will set in three hours.

When the heavy plug surrounding the bottom of the pipe hardens, and there is no longer danger of water seeping down from above, the drill is lowered to eat its way once more into the oil. Then, provided the cementers have done their job properly; another oil well is added to the production line

Cementing also has found a valuable application in the so-called multiple-zone well. This is a well which does the job of two or more individual wells,



Schematic section of an oil field. See explanation in the text each drawing from a single zone of oil. Multiple-zone wells have found widest application in the Wilmington, California, field In this field, the multiple-zone well serves the purpose of permanently separating production of oil at several levels, and controlling each flow individually. Thus oils of various gravities are kept separated, formation pressures conserved, and the flow rates preserved within desired limits.

C. James Dean, field engineer for the General Petroleum Corporation of California, recently reported to a meeting of the American Institute of Mining and Metallurgical Engineers at Los Angeles upon the development of this practice. Accompanying this article is a schematic section, not to scale, of the Wilmington field. It indicates how cement units hold back undesired flows, how two or more zones may be caused to produce through a single well

At *A* in the drawing is shown a multiple-zone well. Oil from the Ranger zone flows between the casing and a blank flow string; from the Upper Terminal zone between the casing and tubing; and from the Lower Terminal through the tubing Packers inside the casing and cement outside separate the various zones

"A multiple zone well," explains Mr Dean, "when properly completed prevents the migration of oil and gas from high-pressure zones to zones of lower pressures *B1* and *B2* in the drawing illustrate an example of migration believed to exist in wells with long unbroken producing intervals. A Full Terminal well producing at a curtailed flow rate is permitting gas and oil from the Lower Terminal Zone to repressure and resaturate a neighboring Upper Terminal well which is producing at the same daily rate from a thinner zone of lesser pressure. This involves not only the monetary value of the gas and oil lost, but, in addition, the limited gas energy is being used to actually drive oil away from the higher pressure well, leaving comparatively dead oil in the Lower Terminal Zone, to be recovered by less efficient mechanical methods. This migration could have been prevented by multiple-zone practice and probably still can be abated by producing the Full Terminal well through tubing hung near the bottom of the hole . . .

Cement in this battery of silos can be loaded in trailers at a rate of 100 tons in half an hour

The fine cement is fed by screws to a cone, from which it is drawn to the slurry box for water mixing

"It is significant, too, that the segregation of the zones permits taking the restricted allowable quantity from the zone producing the most desirable oil The ability to regulate the pressure differentials which cause flow to the well is useful in the control of entrance velocity rates which determine the ability of the entering fluid to carry sand This permits the production of the maximum sand-free rate from each zone."

Where may this technique be applied?

"The drilling of multiple zone wells," says Mr. Dean, "is in general a satisfactory practice on leases with insufficient drilling sites for the individual exploitation of several zones, and as a counter measure to offset wells which are either multiple zone or very densely spaced Another accepted application would be for the development of sands or zones which in themselves do not justify the drilling of individual wells.

"The principal problem in the casing and cementing of a multiple zone well lies in the proper placement of a sufficient quantity of uncontaminated cement behind sometimes very short intervals of blank pipe. Oil zones at locations which offer no intermediate water problems are not difficult to separate with very small quantities of cement. Annular spaces requiring as little as 15 sacks have been filled effectively to separate zones. The necessity for simultaneously effecting a zonal separation and water shut-offs at the top and bottom of the blank interval is a more difficult problem. To do this the pumping of an excess of cement is desirable, which in turn involves the problem of the removal of the excess without cementing off perforations."

How may this feat be accomplished? Mr. Dean continues, describing one successful method:

"The casing is run with properly spaced sections of perforated and blank pipe. At the bases of the blank sections are placed upright cement baskets with the usual cementing parts. At the top of the blank sections are inverted baskets with open ports to receive the excess cement. The inverted baskets are wired to prevent expansion until in place. At the basket for the lowest cement job there is a duplex cementing collar which consists of a solid bottom baffle below the ports and a back-pressure valve above the ports. Tubing is then screwed into, or is sealed off on, the duplex collar and the cement is pumped into place. After displacing the cement, the tubing is raised to the top of the blank section and the excess cement in the casing is circulated out. The procedure at any of the cement points above the lowest is as follows: a cement retainer is set as a bridging plug below the ports, tubing is run and packed off above the ports with a second cement retainer; the cement is then pumped into place and the excess removed as described before

From the slurry box, where the cement-water combination is shown being checked, the mixture is forced into the well by pumps

"This method provides a positive means of placing the cement and prevents any movement after placement due to unequalized columns or circulating pressures. The drilling up of several retainers in the casing is troublesome, but not hazardous."

Rotating Galaxies

That the Spiral Nebulae Rotate is Now Beyond a Doubt. Our Own is Not Much Larger than Others

HENRY NORRIS RUSSELL, Ph.D.
Head of the Department of Astronomy and Director of the Observatory at Princeton University; Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE great spiral nebulae are flat, thin disks—as is proved by the fact that we see some of them edgewise. There is no reasonable explanation for such a shape unless they are rotating. We now know that they are so far away that even very rapid motions would not shift the finest details on our photographs by a perceptible amount except after many centuries. The spectroscope, which measures velocities of approach or recession independent of distance, is our only hope; but observations are difficult, for the surface brightness of these objects is very low, and spectrographs of special design are necessary to concentrate enough light onto the plate to produce an image. Nevertheless, Slipher, in 1914, proved that the great Andromeda nebula was rotating, and Pease, in 1917 (with an exposure of 79 hours!), followed the motion through a region five minutes in apparent, and 1000 light-years in actual, diameter. Within this region the velocity increases steadily with the distance from the center, attaining about 75 kilometers per second at 500 light-years from the center, so that this part of the nebula is rotating almost uniformly at the rate of one revolution in 11,000,000 years.

This is, however, only 5 percent of the distance to the outer portions of the spiral arms, which were then too faint to observe. Twenty years' improvement in spectroscopic design made it possible for Horace Babcock (son of the well-known solar observer), working at Lick in 1938, to carry his measures more than ten times as far—to a distance of 30 minutes, or nearly 6000 light-years, from the center, with exposures running up to 21 hours.

Beyond this the star-clouds are too faint to be observed. But there are several small patches of emission nebulosity—gaseous nebulae belonging to the Andromeda system, as the Orion nebula belongs to the Galaxy—which have bright-line spectra and can be more easily observed. One of these, nearly on the long axis of the nebula, is 96 minutes from the center, corresponding to the enormous distance of 18,000 light-years.

The velocities measured from these spectra showed that, at a distance of about 800 light-years from the center, the rotational velocity reached a maximum, dropped to small values at 1600 light-years, and then increased again, until for the most distant emission patch it rose to 370 kilometers per second, giving a rotation period of 100,000,000 years.

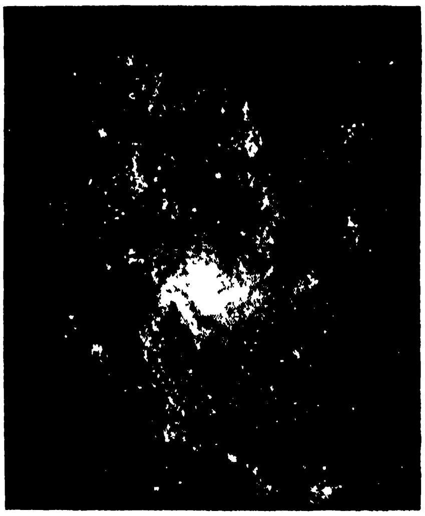


Photo Mt. Wilson Observatory

The magnificent spiral nebula M 33

The only other nebula large enough to be available for a similar detailed study is the magnificent resolved spiral Messier 33 (No. 33 in Messier's Catalogue). This is so faint that the motion of the star-clouds can be studied only close to the nucleus; but there are many patches of emission nebulosity, and no less than 20 of these have been observed by Mayall and Aller at the Lick Observatory. Their results, just published, show that all these objects on the south-west side of the nucleus (as seen in the sky) are receding from us, compared with the nucleus, while all but one on the north-east side are approaching, and place the rotation beyond doubt.

The general form of the nebula indicates that its plane is inclined 33 degrees to our line of sight. Allowing for this (as was, of course, also done for the inclination of 15 degrees for the Andromeda nebula) and adopting Hubble's distance of 700,000 light-years, it is found that the rotational velocities of the condensations increase to a maximum of 120 kilometers per second at 3500 light-years distance from the center, and fall off gradually to 60 kilometers at 600 light-years. The corresponding periods of revolution are about 50,000,000 years at the smaller distance, and 190,000,000 at the larger.

Hubble, reporting briefly on work by Humason and himself, records periods ranging from 3,000,000 years for an elliptical nebula, without spiral arms, to 200,000,000 for the outer parts of fully resolved spirals.

Both in the Andromeda nebula and in Messier 33, the regions along the apparent minor axis of the general elliptical outline show substantially the same motion as the central nucleus. This completes the evidence that the motion is really rotatory, for, at such point, rotation would carry the material of the nebula at right angles to our line of vision, without change of distance. In both cases the nebulae as a whole are approaching us—or, more reasonably put, the Sun is approaching them. This motion, shared by the stars in general in the Sun's vicinity, is itself due to the rotation of the Galaxy, which carries part of it where we happen to be toward these nebulae.

THESE vast motions of rotations demand explanation—not the mere fact of rapid motion, which is no more remarkable than what we call rest (relative to ourselves!), but the fact that the motion is curved, in paths which, on the average, are evidently nearly circular about the nucleus of each nebula. To draw any moving body into a curved path demands attraction—in this case an attraction directed toward the center. The only known force capable of producing such an influence on such a scale is gravitation. The combined attraction of the countless millions of stars which compose the nebula will average out to draw bodies in the direction of the center. The dark matter, which reveals its presence in the form of obscuring clouds, will add to the effect, if there is enough of it.

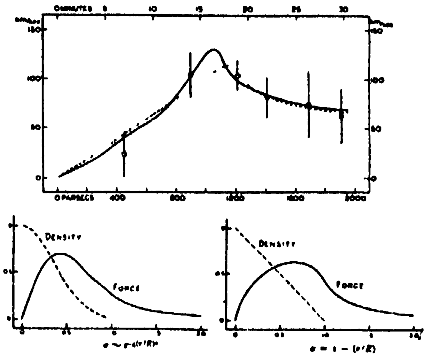
Knowing the radius of the circle described by any point, and the period, the inward force can very easily be calculated. For both nebulae, in the inner region where the rotation period is nearly constant, this force *increases* with distance from the center. If the whole mass, or at least most of it, were concentrated in the nucleus, this would not happen, but, as in the solar system, the orbital velocity would decrease at greater distances. The larger velocity there shows that the attraction of a greater quantity of matter is effective. This would happen inside a uniform spherical cluster of stars. It was shown by Newton that the combined attraction of all the stars nearer the center than the attracted body is the same as if they were lumped at the center, while the stars farther out than this point attract in all directions, in such a way that the net forces in all directions balance, and no effect is produced. As one goes farther from the center, a greater part of the whole mass becomes effective, and the attraction increases.

The nebulae, however, are anything but spherical and it is certainly a much better approximation to regard them as thin disks. In this case the effect is exaggerated. The parts of the disk nearer the center attract with their full force (though not exactly as if concentrated at the center); but the near side of the outer ring now has a greater attraction than the far side, so that its net attraction is outward, diminishing the total force. Outside the boundary of the disk the attraction falls off rapidly.

The expression for the attraction of such a disk is complicated, especially if it is assumed (as is reasonable) that its density is different at different distances from the center. Wyse and Mayall have just published a paper (with nine or ten pages of formulas full of elliptic integrals), have computed tables which can be used for calculation, and have applied these to the two nebulae whose rotations have been observed.

For Messier 33, the situation is fairly simple. Two assumptions regarding the density give a good representation of the facts. In the first, the disk is supposed to get thinner (or less dense) toward the edge, like a very greatly flattened ellipsoid of rotation. The outer radius is 3900 light-years. The second gives a nearly constant density up to 3000 light-years, dropping rapidly to zero at 3500. The observed and calculated rotational velocities are shown in the upper part of the drawing. Both curves fit the observations satisfactorily—the solid representing nearly constant density, the other varying density.

For the Andromeda nebula, where the velocity falls off and increases again, a more complicated model was required, consisting of a small and relatively dense disk of radius 850 light-years, at the center of one of lower density, at first increasing outward, and of radius 19,500 light-years. This curious distribution of density (shown at lower left in drawing) accounts for the still stranger distribution of velocity—according to Babcock's observations—shown at lower right. The very small force, indicated by the slow rotation at 1600 light-years (500 parsecs), arises because this region is well outside the inner disk, so that its inward attraction is much diminished, and inside the region of greatest density of the outer disk, so that its net attraction is outward, and decreases the total force.



Courtesy *The Astrophysical Journal*

Calculated rotational velocity-curves for M 33. Solid line: nearly constant density. Dashed line: density varying according to thickness of an oblate spheroid. The circles and vertical lines represent observations with their probable errors. Lower curves are examples illustrating the relation between density distribution and central gravitational force. Abscissae (horizontal) are distances from the center with the radius of the disk as a unit. Ordinates (vertical) are arbitrary units, which are mutually consistent for the density and the force. From the published paper by Wyse and Mayall

Even this remarkable distribution of velocities may therefore be explained by the gravitational attraction of a quite reasonable distribution of matter.

The masses of the nebulae, resulting from these calculations, are very great. For Messier 33 the two solutions give masses 1,600,000,000 and 1,800,000,000 times the Sun's mass. For the Andromeda nebula, the mass of the small central disk comes out equal to 560,000,000 Suns, while the huge outer region totals 95,000,000,000 times the Sun's mass.

The two systems appear, therefore, to be very different; but it has long been recognized that Messier 33 is not far from being an average spiral nebula, while the Andromeda nebula is in all respects a giant. Our Galaxy is probably even bigger—the Sun is some 30,000 light-years from the center—and there are plenty of stars still visible on the opposite side of the Milky Way, farther out. Calculation of the galactic rotation makes the period at the Sun's distance about 200,000,000 years, and the total mass between 100,000,000,000 and 200,000,000,000 Suns. No system greater than the Galaxy has yet been discovered; yet it does not appear to differ very much from the largest of the others. Shapley's suggestion—well expressing the uncertainty of a dozen years ago—"Perhaps the nebulae are island universes, but the Galaxy is a continent"—would hardly be made now.

The new measures emphasize one strange property of these nebulae, already indicated by earlier observations. A large part of the light of both systems is concentrated into small regions close to the nucleus; but nothing of the sort happens with the mass. The faint outer parts of the Andromeda nebula, which are invisible to the eye, and are revealed only by long-exposure photographs, contain an amount of mass, per square light-year of cross-section, about one tenth that of the central region, but, for equal areas, they send us less than a thousandth part as much light. If both were composed of stars of the same kind—or the same mixture of stars of different kinds—and differed only in the number of stars per thousand cubic light-years, the ratio of mass to light would obviously be the same. There must therefore be an enormous difference in the distribution of the various forms of matter in the two regions. If the central regions were composed mainly of stars of large mass, and high luminosity, and the outer parts of faint dwarf stars, some such difference might occur. But the outer regions are resolvable into stars, which must be very bright to be observable individually even with the greatest telescopes, and such objects are not found near the nucleus, though they should still be observable there. It is hard to escape the conclusion that, in the outer regions, there are great quantities of dark matter, of aggregate mass much exceeding that of the visible stars.

This ties in well with Whipple's conclusion—which we reported last month—that it is in just such regions that giant stars may still be born. We must wait, however, for further data before these questions can be settled, and observation of even the nearest nebulae beside the two already studied will be "an observational problem of the first magnitude"—so Mayall and Aller say—and they know about it from experience. — *Mount Wilson Observatory, March 24, 1942.*

Rubber Facts That Don't Stretch

A Systematic Survey of Minor Emergency Sources of Natural Rubber in the United States

● An outstanding American trait is a penchant for self-deception through wishful-thinking—often rationalized as optimism. Such optimism can, however, be a vice. For example, readers will recall numerous glowing articles in magazines and newspapers during the past decade in which the great expectations from some newly-found and marvelous wild rubber-giving plant or weed were extolled. Yet, somehow, nothing came of these hopes. Now that we need rubber, where are these wonderful weeds? Some of us, it appears, still hope they will jump into the breech and save us. Guayule, of course, is satisfactory, but never was one of the wonderful weeds; it long ago proved up well. But what of goldenrod, rabbit brush, Russian dandelion, and others? Aren't at least some of these *it*? Believing our readers would prefer the truth to optimistic observations, we asked the United States Department of Agriculture for a canvas of the emergency sources of natural rubber in the United States, free from wishful thinking. The accompanying data are what we received. — The Editor ●

There are thousands of species of trees, shrubs, vines, and smaller herbaceous plants that contain rubber, many of which are native to the United States or are known to grow under our conditions, though only a small proportion of the eligible species has been tested. Some are tropical or subtropical plants that probably would have to be confined to southern Florida, while others are native to or could be grown in dry regions like the southwestern states.

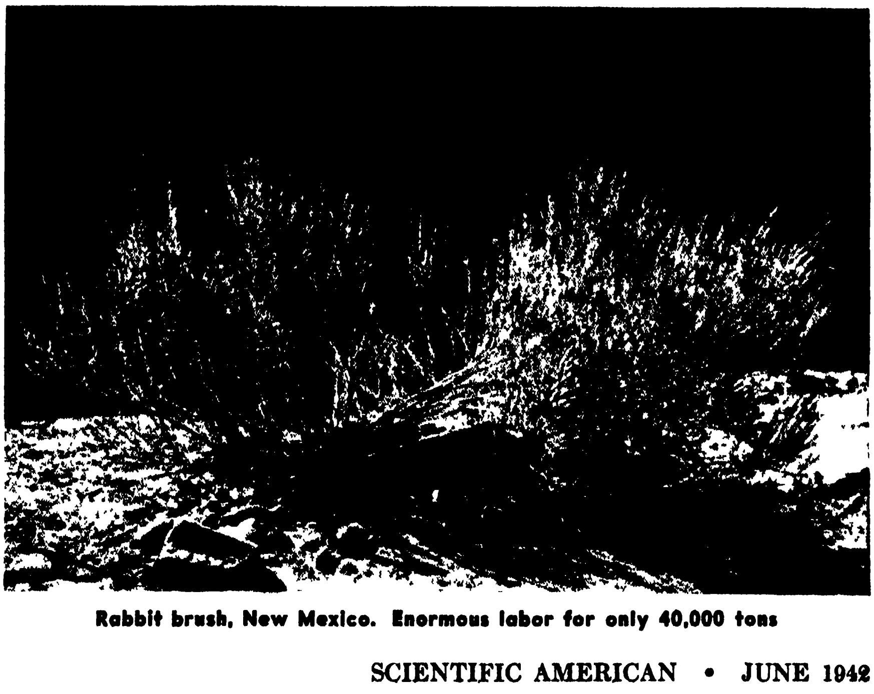
Cryptostegia: Two species of Madagascar rubber vines, *Cryptostegia grandiflora* and *Cryptostegia Madagascariensis*, have been planted in many localities in Florida as ornamentals because of their handsome foliage and flowers. The first species is a large climber, while the second takes the form of a broad, rounded bush five or six feet high. A hybrid of the species also has been propagated and studied in Florida. Rubber obtained from *Cryptostegia* has been tested and found to be of good quality but the present supplies of these plants are limited The percentage of rubber in the roots, stems, and leaves is very low, running only two to three percent, and the cost of extraction of the rubber is high.

Ornamental plants in Florida might yield small quantities of rubber but, for immediate emergency use, propagation or reproduction would be slow and no appreciable tonnage could be expected from this source within the next several years. This is a plant that could be handled by machinery equipped for extracting rubber from guayule but, because of the low rubber content, the extraction is inefficient and costly. Considering the low yield, the time required for production in volume, the difficulties of extracting, and the low percentage of rubber, *Cryptostegia* is not regarded as a practicable source of rubber in this emergency.

Milkweeds: Experiments also have been made with native rubber-bearing plants of the hot desert districts of southern California and Arizona. A promising species is one of the desert milkweeds (*Asclepias subulata*), with tapering, slender stems growing in clumps like a large bunch grass A second desert milkweed, *A. erosa*, also has been tested and found to contain even higher amounts of rubber than *A. subulata*. Methods of cultivating these plants have been worked out, and they could be grown in large quantities in the desert districts. In cultivation tests, the yields of rubber, have been so low that it has never been possible to demonstrate more than 80 to 90 pounds of rubber per acre per year from either of these species. Processes of extracting the rubber and utilizing it commercially have not been developed.

In addition to these two species of milkweed, attention has been given to the common broadleaf milkweed, *A. aspira*, common to the eastern states, but it has proved less promising than either of the two desert milkweeds. Another plant, commonly known as California milkweed but belonging to the composite family rather than to the true milkweed family, is *Stephanomeria virgata*. In spite of publicity recently given this plant, it has been impossible to demonstrate that it contains an appreciable amount of rubber. At the present time, no member of the milkweed group could be considered promising in comparison with the tested quality of guayule rubber.

Euphorbias: This group contains innumerable species of latex-bearing plants closely related to the true Para rubber tree. However, only one of these has ever been an important source of crude rubber. This is *Euphorbia intisy*, native to Madagascar, which was introduced into the United States in 1928. Cultivation experiments with this plant in the United States have been disappointing. It has been impossible to obtain seeds, and reproduction by cuttings has been very slow. It takes a period of many years to grow the plant and the plant must be destroyed to obtain rubber. The common Christmas plant, *Poinsettia*, also is a member of this group and has been promoted and tested for rubber production Reliable tests have demonstrated that the rubber content of this plant



Rabbit brush, New Mexico. Enormous labor for only 40,000 tons

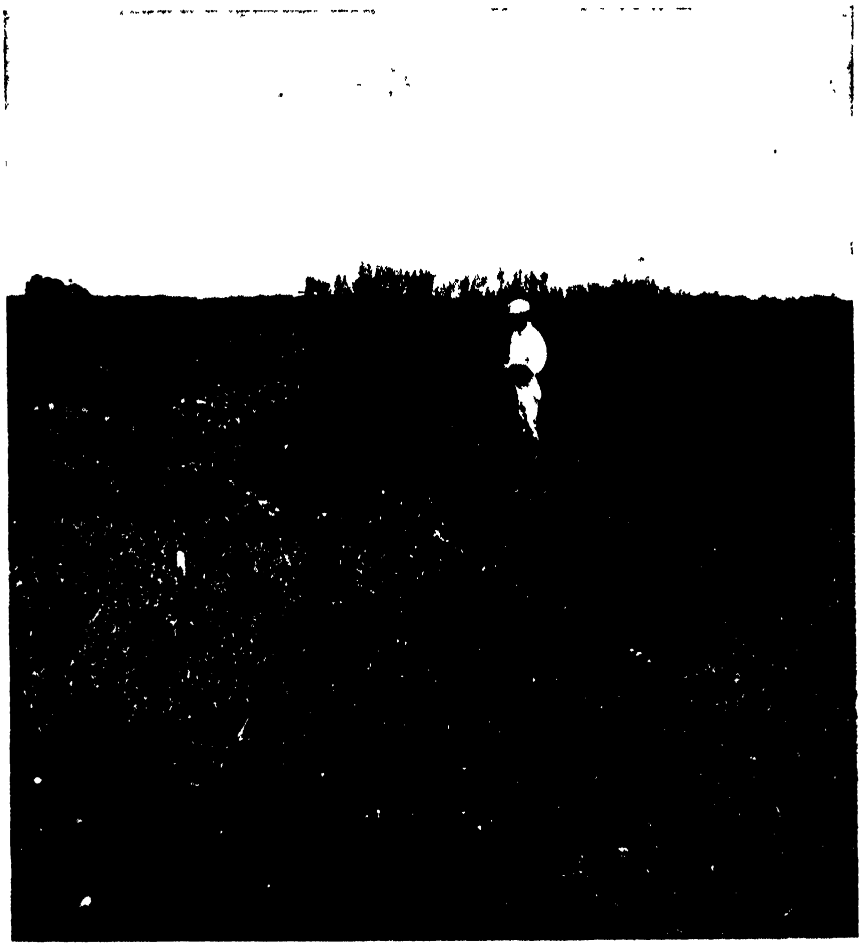
is too low for serious consideration.

Russian Rubber Plants of Anterior and Middle Asia: A number of plants have been discovered and tested in Russia for rubber production. Reports are that several of these have been cultivated on a fairly large scale. Of late, publicity has been devoted largely to the *kok-sagyz*, which is a species of *Taraxacum*, or dandelion.

The current favorable reports on performance of these plants do not appear to be verified by records of actual field performance in Russia received from reliable sources. In contrast to the reported rubber content in the roots of 10 to 27 percent, recent information from Russia indicates that when grown on a large scale by collective farms, the maximum percent rubber is 3 to 5 percent, and the average 1 to 1.5 percent. From the same source, it also appears that the average yield of the *kok-sagyz* root per acre is about one-half ton. On the basis of the maximum rubber content, that would be only 50 pounds of rubber per acre, which is pitifully small. Other plants tested by the Russians are the so-called *tau-sagyz*, which is a species of *Scorzonera*, related to black salsify, and the *krim-sagyz*, also related to the dandelion. Results in Russia are less favorable than those from *kok-sagyz*.

Goldenrod: The late Thomas A. Edison discovered that of some thousands of species native to the United States, which he tested for rubber, the goldenrod showed the most promise in so far as rubber content was concerned. Cultivation experiments were initiated by Mr. Edison and later continued by the Department of Agriculture. Selections with improved yield of rubber were obtained but, up to the present, it has not been possible to produce the rubber in a quality acceptable on the American market. The rubber heretofore produced, on being tested at the National Bureau of Standards, showed a tensile strength of approximately 50 percent of that of comparable compounds using Para rubber and a resistance to abrasion of only 35 percent of that of Para rubber.

In addition, satisfactory methods of extracting the rubber have not been devised, so that the cost of the present method of extraction by chemical solvents is very high and inefficient. For certain uses, rubber from goldenrod is acceptable despite the impurities, but it does not lend itself to large-scale substitution for Hevea rubber. Only a small amount of propagated material of improved strains of goldenrod is available at the present time and a maximum planting of 60 acres in 1942 would be possible, followed by a 20-fold increase in 1943. The use of unselected goldenrod is quite out of the question because of low percentage of rubber and small leaf yield.



Goldenrod. Much talk, but its use is out of the question

Rabbit brush: Many portions of the states of California, Arizona, Nevada, New Mexico, and Utah grow a species of *Chrysothamnus*, known commonly as rabbit brush. This plant contains appreciable amounts of rubber, running up as high as 6 percent of the dry plant content. Results in survey publications of 1919 indicate that appreciable quantities of rubber could be obtained from these wild plants. In many places, the rabbit brush occurs in almost pure stands but such stands are limited to local areas, widely scattered over these six states. The work of collecting and transporting is possible, but would be very arduous and would make large demands upon man-hours of labor.

The rubber has been extracted from rabbit brush by the method used for extracting rubber from guayule and the rubber has been tested and found to be of good quality. The rubber extraction plant in existence at Salinas, California, could be utilized without modification for extracting rubber from rabbit brush, particularly from areas in the Mojave Desert and contiguous portions of California where some of the best stands have been located. It is estimated that as much as 30,000 to 40,000 tons of rubber may be obtained from plants of this species actually growing, but at enormous labor cost.

Osage Orange: Because of its milky juice, osage orange or hedge apple, botanically known as *Maclura pomifera*, has attracted attention as a possible source of rubber. Interest in this plant dates back to before 1910 and studies have been conducted by many investigators. Tests conducted in the laboratories of the Department of Agriculture have failed to show even 1 percent rubber in the fruits of osage orange and analyses of other parts of the plant have been equally disappointing.

Microöganisms: Synthesis of rubber by the use of bacteria or other microorganisms has been suggested as a possibility. The idea is to inoculate expressed juice of rubber-bearing plants and increase the amount of rubber yield from a given weight of the plants. As the rubber-bearing plant, itself, synthesizes rubber, there is no reason to doubt the possibility, providing the necessary elements or materials are in the expressed juice, or in the air and available to the microorganisms, but successful use of such methods to produce rubber have not been demonstrated.

From The Ground Up

Our Chemical Industry Had the War-Time Advantage of Starting Practically from Scratch

DOUGLAS M. CONSIDINE
Chemical Engineer

THE production of explosives and munitions constitutes a very minor part of the great American chemical industry in peacetime. Even in times of war, munitions production does not completely overshadow production of other chemicals and chemical commodities commonly identified with peacetime usage. Thus the chemical industry, today, is playing a most important and dual role in our war preparations; namely, by producing explosives and materials commonly identified with war, and by expanding production of such essential peacetime commodities as petroleum, rubber, and plastics. Of great significance is the fact that petroleum refining and rubber and plastics production are as dependent upon chemical technology as is the actual production of explosives.

In the fall of 1940, when an initial sum of $75,000,000 was made available to the War Department for construction of munitions plants, the stage was set for possibly the greatest task ever to be undertaken by the chemical industry of any nation. That long list of military ingredients, which has since become so trite, was placed on order for delivery as soon as possible. But nearly all the plants for this production were still on paper, or yet to be designed. We did not have any Krupps or Schneiders; we had neither a Skoda Works, nor a Vickers Armstrong, Limited. In a European sense, we had no munitions industry! Our peacetime facilities could supply no more than 10 percent of requirements and these plants were already on a 24-hour basis making munitions for Britain.

America's disadvantage in having to start from the ground up was not without assets, the greatest of which proved to be our ability to locate these plants according to all the best lessons of economic geography. Several factors were considered before the plant sites were selected. Despite the huge sizes and great capacities involved, expansion for the future had to be considered. Incidentally, this early foresight has proved a boon to expediently carrying out America's second great munitions program. As remote as an air attack on American soil seemed in 1940, the possibility of long-range bombing operations had to be considered. A strip 200 to 250 miles deep from the geographical boundaries of the United States was ruled out. New munitions plant construction was to be reduced to a minimum in this limited zone. World War I munitions production was confined chiefly to a geographical triangle, of which Boston, Pittsburgh, and Wilmington were the vertices. This resulted in critical power and transportation problems. Our great World War II industrial load had to be distributed as evenly as possible throughout the nation. In addition, availability of labor and raw materials, usually the primary guides in peacetime plant location, had to be weighed on the plant location balance. Good transportation facilities and power in large quantities had to be available to this great new industry. Coal and water had to exist nearby in great abundance.

SELECTION of sites in Illinois, Indiana, Virginia, and Iowa seemed a bit surprising until the War Department's fundamental policy became more evident. These plants were being located where there were vast undeveloped reserves of labor and natural resources. A new geographical network was being laid. As a result, the new munitions plants are drawing most of their workmen and supplies from neighboring vicinities, tending to eliminate the sacrifice and strife involved when labor migrates to cities and industrial centers already overcrowded. The difficulties which some communities have suffered to date from this cause are insignificant, as compared with the situations which would have been precipitated had this factor not been in the foreground when plans were being made.

This forethought will greatly aid the industrial situation when the present emergency has passed and these plants are put on bank. In the meantime, we may expect these plants to grow into centers for important peacetime industries. Munitions plants are chemical plants and the chemical industry is turning more and more to farm products as a source of raw material. With the equipment on hand to conduct the unit operations of chemical engineering, so-called "Chemurgy" may find a boon in these newly created industrial areas, tending to unite the chemical industry and agriculture into one great beneficial combine. When one realizes that all these factors and many more had to be seriously considered, the War Department may not only be excused, but lauded for using good farmland for the location of plants devoted to the manufacture of munitions and to other wartime activities.

One of the nation's largest combined shell loading and TNT plants rapidly took form in a mid-western state. Over 280 farms, comprising 38,000 acres of fertile farmland were converted into a great arsenal occupying some 35 square miles. Adjoining this Ordnance Works is a great shell loading works with an area of 22 square miles. Cost of the Ordnance Works was approximately $48,760,000 as compared with a cost of $22,000,000 for the shell loading plant. An expansion of these plants at an expansion of these plants at an expenditure of $9,400,000 has already begun. The Ordnance Works includes some 450 buildings and is surrounded by over 40 miles of unsurmountable fence. The shell loading plant includes some 500 buildings, several of which are powder and ammunition magazines.

THE principal raw materials for the preparation of TNT are toluol, sulfuric acid, and anhydrous ammonia. Toluol will be shipped to the Ordnance Works from a plant in Texas and from by-product coke ovens in the Chicago area; sulfuric acid will come from Chicago plants; ammonia will be shipped in tank cars from plants in West Virginia and Kentucky.

Loading and assembling shells will be the primary function of the shell loading plant. Empty shells and cartridges will come to the loading plant from scattered midwestern factories. High explosives for shells will come primarily from the neighboring Ordnance Works, while smokeless powder will come in bags from an Ordnance Works nearby. Facilities at the shell loading plant for loading airplane bombs, artillery shells, and fixed round ammunition will center about three loading or manufacturing lines. Of industrial interest is a conveyor line costing approximately $500,000 which carries shells through the long loading lines.

A small village in a nearby state

has been transformed into a thriving community and the site of America's largest smokeless powder plant. Over 20,000 people were engaged in $75,000,000 worth of construction to erect this plant. The plant site covers an area of thousands of acres; over 50 miles of standard gage railway track and 25 miles of narrow-gage track are required to serve some 650 buildings. Over 20 miles of water main are required to carry water to satisfy this plant's enormous requirements.

This plant exemplifies the great care exercised by the War Department in locating munitions plants. Located inland, it is practically immune from all but longest range aerial bombers. This plant is able to draw on the large industrial populations of nearby cities. A river provides an unlimited supply of water and a convenient means for diluting waste products. Transportation facilities, both rail and highway, are excellent.

The story of this plant is an epic in the history of great American chemical and powder plants, but only typical of the great series of similar plants now completed or under way. Construction of the plant started on Sept. 3, 1940, and proceeded with great rapidity. Soon after that date, modern ditching machines were digging foundations. A concrete plant, with a 2000 cubic-yard-per-day capacity was installed. Roads and railroad trackage suitable to construction purposes were rushed to completion. Steam required at the various parts of the huge plant site could not be purchased locally. This problem was expediently solved by renting four large railroad locomotives which served as mobile units, supplying steam requirements wherever needed. Twenty thousand board feet of lumber required were supplied by a saw mill built right on the grounds. Notwithstanding the immensity of this undertaking and the role that time played, confusion was reduced to a minimum and an All-American construction safety record of 4,000,000 man-hours without a single lost-time accident was established.

Ammonia, cotton linters, sulfuric acid, and alcohol are included in the list of important raw materials required for smokeless powder production. Ammonia will come to the Ordnance Works from a plant in Kentucky; cotton linters will be brought up the river from the south; great sulfuric acid plants in Tennessee will supply this vital ingredient; alcohol will come from nearby midwestern plants.

The first of Uncle Sam's new ordnance plants to begin production was in Virginia. Construction of this $40,000,000 plant was started late in 1940 and required the employment of some 22,000 workers. Production of smokeless powder began just five months later. A few miles away was constructed another Ordnance Works, a $10,000,000 plant which will load part of the smokeless powder produced at the first plant into bags for use in large caliber guns. The third of three smokeless powder plants scheduled on the War Department's first program is under construction at a cost of $48,000,000. The second program calls for a $60,000,000 smokeless powder plant.

Other arms, ammunition, and explosive plants on the first program, now under construction or in operation, include a shell loading plant—cost $17,000,000; a TNT-DNT plant—cost $11,000,000; a TNT-DNT plant — cost $9,388,000; and small-arms munition plants at costs of up to $30,419,000. The first program also called for two $1,000,000 plants for the production of activated carbon.

Expansion of the first program calls for additions to practically all of these plants at costs, in most cases, in excess of the original investments. Included in the outstanding new plants of the second program are a $26,000,000 TNT-DNT-Tetryl plant and a $33,500,000 ammunition loading plant. Even this by no means completes the lists of plants now proposed or under construction.

Despite the fact that we had practically no munitions industry in 1940, our chemical preparedness was considerably better than the period of World War I. In many cases, our 1940 peacetime production of strategic raw materials used in munitions manufacture was considerably greater than the peak of World War I production in 1918. For example, in 1918, we were producing 75,000 tons of ammonia per year. Today, our synthetic ammonia production alone totals several times this figure. But even with this great production, plus ammonia obtained from other sources, our present ammonia production, which momentarily appeared bright, is, in reality, only about one half of estimated requirements; chlorine production is in somewhat the same status.

As stated previously, our production of munitions in 1940 was sorely lacking, from a war-time viewpoint. In 1918, we were producing 192,000,000 tons of TNT per year, while in 1940 production was only 10,000,000 tons; early defense needs for this high explosive were estimated at 600,000,000 tons. In 1940, we had practically no commercial production of picric acid, as compared with the 1918 production of 140,000,000 tons. Smokeless powder production in 1918 amounted to 513,000,000 tons, as compared with our 1940 production of 30,000,000 tons and a total estimated requirement of 900,000,000 tons.

The comparative abundance of some war-time raw materials and lack of others may be explained primarily by the fact that many materials, essentially concerned with war-time usage in 1918, now have found their peacetime counterparts. Many others have not. Thus, we find ammonia used in hundreds of chemical processes for the manufacture of peacetime goods, while a peacetime place for picric acid has not been found.

Toluol is the basic raw material for TNT. Large amounts of TNT are used in airplane bombs which carry up to 60 percent of their weight in TNT. This is a lot of TNT in bombs weighing a ton or more each! Artillery projectiles carry 15 to 20 percent of their weight in TNT. Before World War I, our primary source of toluol was the by-product coke oven, with a capacity of about 100,000 gallons per month. This production was stepped up to 800,000 gallons by April 1917. An expenditure of $30,000,000 provided additional coke oven capacity in plants of eight large steel companies and new ovens at five other mills had been contracted for at the time of the Armistice. But toluol from coke ovens was not enough! In November 1917, construction was started on plants for stripping toluol from domestic heating and illuminating gas. The first plant of this type, a $7,500,000 project, went into production in April 1918 and, throughout the duration of the war, 13 large cities used gas with 6 percent less heating value.

Finally, a third source of toluol—petroleum—was tapped. Toluol was produced at a monthly rate of 400,000 gallons in several California refineries and all doubts of adequate toluol supplies were erased. This represents the mad scramble for toluol during World War I and it must be remembered that toluol is only *one* raw material used in munitions production. This scramble proved successful. Our Army's requirements were filled, 11,000,000 pounds were shipped to the Allies, and 17,000,000 pounds were left over at the time of the Armistice

Today, our toluol problem is large, but vastly different from that of World War I. The solutions are more obvious and easier. The important questions, today, are those relating to minimum costs and maximum industrial convenience. Great strides in research and experience in the present conflict have placed the petroleum industry in an effective position to fill the gap in toluol production. The coke oven remains our primary source of this strategic raw material, however. Better equipment and methods now make it possible to obtain from 20 to 25 percent more toluol per ton of coal coked than was obtainable by the methods of 1917.

Our nitrogen needs are being bolstered by the construction of several new ammonia plants. Nitrogen is an important ingredient of nearly all explosives. It is estimated that ammonia production from privately-owned plants will reach over 1000 tons per day. One government-financed plant of 450 tons per day capacity is being constructed in West Virginia; several government-financed plants of 250 tons per day capacity each are scheduled for construction in Kentucky, Alabama, Louisiana, Missouri, Kansas, Arkansas, and Ohio. We must be concerned with one fact; from 18 months to two years are required to construct a synthetic ammonia plant, as compared with other munitions plants which can be built in eight or nine months.

Sulfuric acid is vital to munitions production and, today, is made principally from raw elementary sulfur, or brimstone. Today, our sulfur resources and facilities for producing sulfuric acid are among the brighter spots in the War program. This is due to the great quantities of sulfuric acid consumed by peacetime industries. Our sulfur problem during the early stages of World War I was a sorry one, however. Prior to that time, most of our sulfuric acid was prepared from Spanish pyrites, a sulfur ore. Prior to 1917, we were able to obtain all our requirements of pyrites, but soon after the initiation of unrestricted submarine warfare, shipments from Spain became increasingly difficult. We turned more and more to our domestic pyrites, but, in 1918, we found our sulfuric acid requirements for the next 12 months at approximately 8,000,000 tons, with sufficient raw material on hand for only 5,000,000 tons.

Perhaps the situation was fortunate —it resulted in the birth of a new American industry. In 1916, drilling near Martagorda, Texas, indicated the presence of large amounts of brimstone underground. Early in 1918, the government pushed exploitation of these resources without further delay. Since that time, there has been a marked development of our brimstone sulfur resources. Today, this greatly overshadows all other sources of raw material for sulfuric acid production. At present we have over 4,000,000 tons of brimstone on hand, representing over one and one-half times the highest annual consumption of American sulfur during any one period up to the present time.

Other strategic war materials in the realm of chemistry include petroleum, rubber, synthetic fabrics, plastics, activated carbon, drugs, pharmaceuticals, and the like. It is interesting to note that we now have from two to three years supplies of such important drugs as quinine, iodine, and opium on hand.

Just as the American chemical industry is better prepared now than in 1914-18, so is the American chemical profession. During World War I, plants established by the government, such as the chlorine and phosgene plants in Maryland, the Lewisite plant in Ohio, and the cyanide plant in Virginia, availed themselves of nearly every chemist who could be found. Today, most of this type of material is being produced by government-financed or subsidized plants and operated by private corporations. In contrast with World War I days, we have the world's most highly developed and efficiently operated chemical industry, an industry which literally produces dozens of new products daily. Our chemical industry is no longer an infant, but holds a high position in America's list of great industries. We have thousands of chemists and chemical engineers educated and experienced in this highly specialized work.

Research, especially chemical research, always will be our first line of defense and offense. We must remember that despite the vast magnitude of the present emergency program, it is of a comparatively rapid, short-range nature. As Sidney D. Kirkpatrick, President of the American Institute of Chemical Engineers, states, "We should not entirely overlook the fact that some time in the indefinite future we are coming to D-Day. Industry is going to have to be De-mobilized (or perhaps Re-mobilized) for Peace." With this thought in mind, company executives and research directors of far reaching vision and imagination are beginning to plan their remedies for reducing the great post-emergency headache to the smallest possible pain.

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TO REPLACE COPPER

Thermoplastic Tubing is Chemically Resistant

A FLEXIBLE, semi-transparent tubing of thermoplastic Saran is now available to the chemical industry as an alternative for copper and other metal tubings, according to The Dow Chemical Company.

Developed through years of research, this tough, chemically resistant tubing may be used in many applications previously demanding copper except where high temperatures and very high pressures are encountered. Also, Saran tubing has been tested and proved suitable to replace such strategic materials as nickel, stainless steel, copper, and ceramics in several fields where its properties are advantageous

Saran is characterized by toughness and resistance to moisture, brines, solvents, acids, and alkalies. Another feature of this plastic material is that it may be used for short periods of time at temperatures of 250 to 275 degrees, Fahrenheit, although its strength and resistance are somewhat reduced at these elevated temperatures.

Available in sizes one-eighth inch to five-sixteenths inch outside diameter with wall thicknesses varying from .030 inches to .062 inches, this tubing may be joined by Parker standard tube couplings and S.A.E or other flare type fittings. Already the Mueller Brass Company is developing fittings for Saran tubing which permit the construction of a tubing system in which contact between such fittings and the material conveyed is entirely eliminated

EYES OF DEFENSE

Instruments Made on Production Basis

MECHANIZATION, the basis of modern warfare as contrasted even to World War I, depends for its every movement, as well as for many actual combat actions, on information supplied by instruments. Anti-aircraft guns get their range by instruments. On an airplane cowl is a bewildering array of dials. Even the tank must have its two-way radio or its range finders. Almost any implement of warfare, beyond the rifle, has its operator watching the movement of a slender dial needle.

The production of the millions of instruments needed for defense has imposed on the instrument maker the greatest burden he has ever known. How well he does his job will affect the outcome of the world struggle. A look at the results to date are reassuring. For example, Uncle Sam urgently needed 5000 D.C. switchboard ammeters in a variety of ranges as part of a mine-sweeper modernization program. Although this represents a normal year's production of this type instrument for Westinghouse, the 5000 were built and delivered to a half dozen navy yards in 28 calendar days. This is one concrete refutation of the often-heard charges of lagging production. Unseen behind this achievement lies progressive engineering that has created the relatively few but interchangeable parts needed, and coordination of products and methods that has nullified the disturbing effect of a wide variety of sizes and types. It is, in short, a tribute to the production-line, interchangeable-part idea that, fortunately for our defense program, has been so successfully incorporated into instrument manufacture just in time for the present emergency. It shows one thing more—the remarkable elasticity of the production-line system—the weapon with which the democracies will outfight totalitarianism.

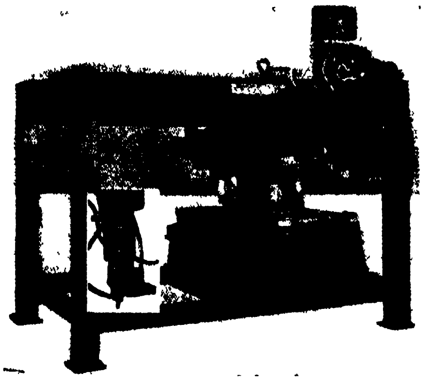
In addition to the thousands of standard instruments, there are many new types that have called for the utmost in engineering ingenuity, but which for military expedience must now be secret. In this group are those for aircraft blind landings, for protection of vessels against magnetic mines, and scores of new aircraft radio instruments.

WALKING WELDERS

Make 80 Spot Welds In 12 Seconds

KNEE-ACTION walking welding guns are the latest innovation in the resistance welding field. Developed by Progressive Welder Company, they permit performing of multiple welds in sequence in an automatic machine, where it is preferable to hold the work stationary in large fixtures. The manner in which this is done is illustrated in a machine developed for welding the back panel into a refrigerator shell.

The machine is designed to handle two sizes of such shells, and welds one assembly while another is being loaded and unloaded. Shell and back panel are dropped over the locating fixture, which incorporates the lower electrode. Clamping is by air pressure. (One fixture has been removed, in the photograph, to show the clamping mechanism at the side of the fixture.) When a button is pressed, the entire operating head of the machine moves to a position above the loaded fixture. Pushing another button starts the automatic welding operation. The four gun points come down and make four welds. At the same time the chain has started to move. The motion of this chain is continuous, carrying the heads of the welding guns along. Weld time is controlled by an electronic timer. When the weld is completed, the pressure is off the gun points, and these points swing—under spring pressure—to a new position farther along (depending on the amount the chain has moved). Another weld is made automatically, and the guns take another step.



Push-button operated

To complete one assembly, each gun takes 19 steps and makes 20 welds, 1½ inches apart. While the shell is being welded, the other fixture is being unloaded and re-loaded. The machine operating head now moves above over the second fixture and repeats the cycle, except that the movement of the guns is now in the opposite direction, the chain reversing its travel at the end of each complete cycle of welds. Off-time, between welds, to permit the guns to move on to the next spot before welding current comes on, is controlled automatically by a notched timing disk.

Time for the complete welding cycle is approximately 12 seconds, during which time 80 spot welds are made.

SCRAP NICKEL

Recovery Possibilities Up To 1,000,000 Pounds a Month

FROM 20 to 40 percent of the total tonnage of alloy steels delivered by mills to manufacturers are lost in machining and other processes of fabrication. Sometimes net losses may run to 70 percent, and—in complicated operations—up to 80 percent. Nickel content in the case of automotive and similar type low-alloy steels runs from slightly over 1 percent to over 5 percent. In stainless steels the figure often may rise above 10 percent.

The alloying elements in these materials are largely reclaimable, but in the past most of them have been lost—though the stainless steels, to an extent, have been an exception. They have been lost by a general practice of mixing the alloy-steel scrap with carbon-steel scrap and disposing of it as carbon steel. The extent of this practice is indicated by the fact that in the past year the residual nickel content in miscellaneous scrap as revealed by periodic examinations was approximately 0.05 percent.

This residual nickel enters carbon steel through alloy steel mixed with ordinary carbon-steel scrap charged into the furnaces with pig iron. An average of 50 percent scrap is used in the usual furnace charge. In other words, this nickel enters by mistake or failure to segregate alloy from carbon-steel scrap. It is too low in content to add appreciably to the qualities of the steel. It remains buried but under proper conditions could have been saved.

During the past year approximately 70,000,000 tons of steel were produced. At the average figure of 0.05 percent residual nickel this tonnage would account for 70,000,000 pounds of nickel. This nickel might well have been salvaged had scrap segregation been systematically carried out over the years in which, through cumulative effect, this quantity of residual nickel was being built up.

Steel production is mounting rapidly. During the first eight months of 1941, for instance, more scrap was used than in any other year of the steel industry's history. Hence the concern of both government and industrial leaders for an intensified nation-wide salvage campaign.

As indicated, segregation is the springboard for recovery of essential alloying elements. It means far more, of course, than segregation of alloy-steel scrap from carbon-steel scrap. No general specifications for such segregation according to percentage of nickel content have yet been completely outlined, though numerous divisions along these lines not only have suggested themselves, but also are being carried out in a number of cases.

While all scrap containing nickel is valuable and should be segregated so that the nickel content can be salvaged, it should be obvious that scrap containing 2½ per cent nickel or higher is far more valuable to the producing mills than scrap which, through dilution, runs 1½ per cent nickel or under. On the basis of present nickel-steel consumption it is estimated that up to 1,000,000 pounds of nickel a month may be saved for producers and users of these nickel-steels by careful scrap segregation.—*Inco.*

INDUSTRIAL TRENDS

DOWN TO THE SEA FOR METAL

If ever a search were conducted for the most versatile metal in commercial production, magnesium would probably finish at the head of the list. One third lighter than aluminum, it can readily be used in alloys of light weight and outstanding strength. Such alloys, usually involving aluminum, zinc, and manganese, are easy to machine. An example of the resulting light weight of these alloys is found in magnesium alloy wheels for large bombers, which, substituted for aluminum wheels, show a weight saving of some 100 pounds.

But weight and strength alone would not be sufficient to place magnesium at the top in versatility. It has other qualities that are of particular interest in wartime, yet are not unusable in times of peace. Thus, the metal can be ignited to burn at the intense heat of 1300 degrees, Centigrade, giving off at the same time a brilliant light. If water is poured on the burning metal a violent explosion takes place. Direct a stream from a carbon tetrachloride fire extinguisher on such a fire and the deadly gas phosgene is evolved. Ignite a quantity of the metal in powdered form and an explosion will occur. These oxygen-hungry properties of magnesium make it ideal for use in incendiary bombs, tracer bullets, flares, and other wartime applications.

It is not to be wondered at, then, that production of magnesium is being stepped up many times in an endeavor to make full use of its qualities for the diversity of purposes of war into which it fits. Yet, strangely enough, there was no commercial production of this metal in the United States until 1915, when supplies from Germany were cut off by World War I. During that year only about 87,000 pounds were produced in the United States; scheduled production for 1942 is several hundred thousand pounds.

Like aluminum, magnesium does not occur as a free metal in nature. There are large quantities of magnesium-bearing ores in existence in some of the western states, but the principal source of the metal is brine from the ocean or from salt wells in the middle west. From these brines is extracted magnesium chloride which, in turn, is subjected to an electrolysis process to obtain the pure metal. Another method involves the reduction of magnesium oxide through the use of carbon and electricity, hydrogen being used in one of the steps to obtain the free metal. Still a third process has been developed, known as the ferro-silicon process, which, it is claimed, uses less electricity than other methods, and is less expensive in other phases.

Be that as it may, the one company in the United States that has pioneered in magnesium production, and which undoubtedly can most definitely be depended upon to indicate the present and future trends in the industry, is the Dow Chemical Company. With extraction plants at various ocean fronts and with brine wells in the middle west, this company is not only a metal producer but a fabricator as well. In such a position, and with huge expansion plans for war purposes well underway, this company, together with ten others now in the field, may seem to be in the position of war babies that will some day find themselves so over-expanded as to face possible industrial disaster.

Such disaster might indeed be a possibility if it were not for two important factors. First, potential uses of magnesium in industry are just beginning to be explored. Second, Dow's operations in the extraction of magnesium from brine are only a part of a chemical business using the same basic material. From the same source are being obtained such varied finished products as bromine, iodine, alkalies, chlorine, and so on—all chemicals with huge present and potential demands.

But to stick to magnesium for a moment: Increased production and improved methods have already resulted in decreased costs which may be expected to decrease still further as production is stepped up. This factor alone has made it possible to invade many fields hitherto closed to the metal. Aviation is, of course, the most obvious and the one that is receiving the greatest attention at the moment. It naturally follows, then, that the lessons being learned in building military aircraft are going to be applied to the aircraft industry of peacetime, and that magnesium alloys are going to loom large in plans of the industry after the war. Then there are the fields of the automobile, the railroads, the electrical industry, all of which will welcome the advantages to be had from magnesium alloys made available through low cost of the pure metal. Household appliances such as washing machines, vacuum cleaners, fans, and so on, when once more put into production, will find wide use for the light, strong, inexpensive alloys.

With these facts alone in mind, the trend of the magnesium industry is a healthy one for the war of the present and the peace of the future. Couple it with the extraction of other raw materials from brine, mentioned above, and salt water, in the hands of the chemist, promises to loom large in the industrial picture.

GLUE RELEASES STEEL

That this is an age of metals, and that this war is a war of metals, is one of those obvious truisms that upon investigation discloses other factors which render the truism only partly correct. While the demands of armaments have thrust metals to the fore, these same demands have created vastly increased uses for man's oldest constructional material—wood. And these increased uses are not only in civilian fields where wood is employed as an alternate for steel, but for military purposes as well, where strength is needed but where the other qualities of metals are unnecessary.

One of the factors that have contributed largely to satisfactory applications of wood in a diversity of uses has been the development of glues which are strong, weather resistant, easily applied, and not attacked by the fungus growths that can render some glues unsatisfactory for use over extended periods of time.

Indicative of the trend in the glue industry is the fact that many government projects are using laminated arches made up of layers of wood securely bonded with glue. These arches are going into the construction of airplane hangars, armories, ship-building sheds, and factories. In addition, thousands of government workers as well as service men are being housed in dwellings of glued construction. In California alone, it is reported, there are some 5000 living units of this type.

Aside from the savings that can be realized in structural steel through such wood and glue construction, there is the saving in nails which, at first glance, might seem unimportant. But, it is estimated, 100 pounds of nails are saved in every FWA home now being put together with glue. Multiply this by many thousand units and the sum total certainly indicates a trend in future building construction.

—The Editors

THE LONE INVENTOR

Edison, Howe, Whitney, and a host of others are names that conjure up visions of the lone inventor. Working long, weary hours, often under circumstances of dire need, even hunger, these men struggled on, reached the pinnacle of success through sheer inventive genius. That they often worked alone may have been a fortunate circumstance rather than a serious handicap. Coming before the era of inventors backed by the almost unlimited resources of the modern industrial research laboratories, these men have become symbolic of a period in the development of our country which often but erroneously is thought to be gone forever.

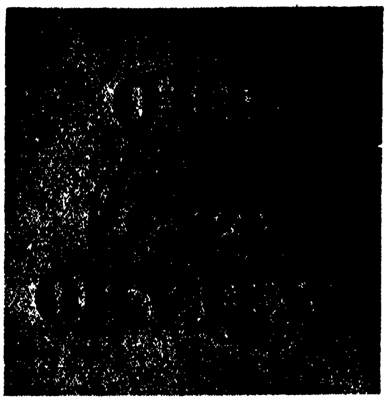
True enough, inventing has today been brought to such a point of perfection by industry that casual consideration of the subject might easily lead to the conclusion that the day of the lone inventor is past. How far from actuality would be such a conclusion may be found by skimming the weekly list of United States patents issued, as published in the Official Gazette of the United States Patent Office. Here will be found recorded official recognition of hundreds upon hundreds of the brain children of individual inventors who have labored as faithfully, suffered as keenly, struggled as heroically as any of the honored inventors of the past three generations whose names are now part of our nation's industrial and scientific history. And—what is even more important to many—these brain children frequently form the foundation of fortunes for the men who gave them birth.

No, indeed, the day of the lone inventor has not vanished. Today the opportunity for individual effort is as great as, if not greater than, ever before. Thousands of keen minds, rendered even keener by the pressure of industrial production necessitated by the exigencies of war, are at work throughout the country on new, often strange jobs, turning out the materiel demanded by our armed forces. As these minds are applied to the problems at hand, they are absorbing new knowledge, finding new ways of doing things better, faster, more easily. And, relaxing during hours off the job, these minds often and naturally dwell on the work of the day and of days to come.

What is more to be expected, then, than to find the possessors of these minds turning to home workshops and laboratories to try out new ideas, to experiment with some new twist that flashed out of a seeming nowhere into a receptive medium?

Those whose intellectual curiosity or mechanical talent constantly urges them onward into fields of exploration have a bright and fruitful future ahead. They must not let the war ruin their perspective but, rather, should take every advantage of the opportunities being offered by the demands of the moment. There is great need of inventions for furthering our war efforts to a successful conclusion; there is likewise great need for inventions in civilian lines, particularly for use after the war.

If, then, the individual inventor, as he develops his ideas, finds that some of them have no apparent applications today, he should not too quickly abandon them. Careful scrutiny may indicate future possibilities. Such inventions should be just as thoroughly protected as if they were going into production tomorrow; lack of foresight in this respect may lead to bitter disappointment and financial loss in the future. The effort and investment needed to obtain such protection is relatively small when compared with the losses that may be sustained when the need for the invention is discovered and it is found that protection is lacking.—*A. P. P.*



FOR BETTER SHOOTING

In the April and May issues of *Field & Stream*, Arms and Ammunition Editor Bob Nichols describes a new type of gun-mount, adaptable to .50-caliber machine guns and 37-mm anti-tank guns. The compelling feature of this mount is its maneuverability which, while revolutionary compared to existing military usage for this class of fire power, is an old story to the American bird hunter. Like the shotgun at the hunter's shoulder, the machine gun or anti-tank gun, through application of this mount, may be rotarily swung through 360 degrees. Coincidentally with the rotary movement it can be elevated or depressed 90 degrees. In a quoted letter appearing in one of the *Field & Stream* articles, the gun-mount inventor states the Army and Navy are "trying to hit dive-bombers and low-strafing planes with slow, fixed gun-mounts—too heavy and too slow to swing on the target . . . using three men to aim, sight, and fire one gun—an attempted co-ordination that is impossible to achieve in the split-second time allowed on fast-moving, twisting, and diving targets." Although presentation of the mount was made last January before all branches of the service and, writes the inventor: "all tests were completed successfully—and the test operator ended up by shooting a buzzard out of the air at least 500 yards out," there has, at this writing, been no official adoption of the mount. While we are not in a position to substantiate the inventor's claims for the physical perfection of his mount, we heartily subscribe to the theory of maneuverability involved—as old, as tried, and as true as the technique of shooting game birds on the wing, or jackrabbits on the hop. In either offensive or defensive warfare the adoption of the theory of properly leading a speeding target—a theory proved sound by generations of American hunters—would, we believe, make it possible to knock more enemy planes and tanks out of action.—*A. D. R., IV.*

NAVAL ARTICLES

In our issue for May we presented an analytical article on the battleships of the United States Navy, the article to be the first of a series. The present number does not carry the second article because of the war-time censorship to which Scientific American has voluntarily submitted. The manuscript of the second article was submitted to the Navy Department for approval, but such approval was not granted. As soon as we can obtain clearance, in a form satisfactory to the Navy Department and to the Office of Censorship, these articles will be published.—*O. D. M.*

Harnessing the Sun

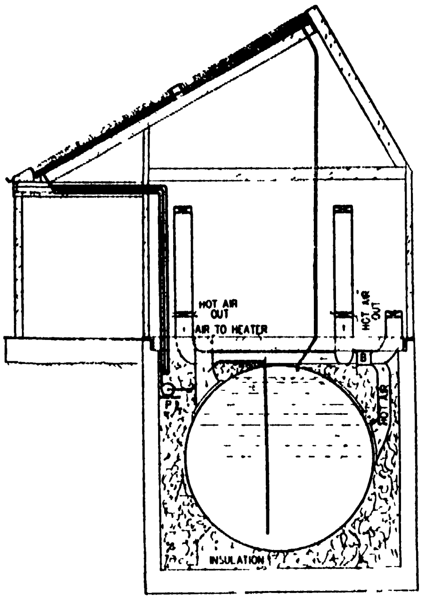
Research on the Practical Problem of Power and Heat from the Sun: A Progress Report from M. I. T.

JOHN A. SIBLEY

As man's society becomes more and more complex, his energy requirements increase at an immense rate. The cave man, whose only need was about 2000 calories of food a day, used the equivalent of about one half pound of good-grade bituminous coal per day, or about 200 pounds per year. Yet a modern man, living in the midst of thousands of mechanical devices which require energy both in their manufacture and use, consumes over ten tons of equivalent coal a year, or over a hundred times the energy actually needed by the body. This rate is constantly increasing; the last 60 years, during which America has changed from a young agricultural nation to the most highly industrialized nation in the world, have seen this country's fuel requirements increase six-fold. As technological advances are being made every day, there is little doubt that an even greater supply of energy will be needed in the future.

The sources of energy have likewise changed. During this same 60-year period, wood has declined in importance from 60 percent of the total to only 6 percent. Coal rose to a peak of about 80 percent in 1918 and then decreased due to the development of the oil industry. At the present time anthracite and bituminous coal supply about 45 percent of the total; petroleum and natural gas supply about 36 percent; water power supplies about 10 percent; and the small remainder is furnished by wood, food, and wind. With the exception of wind and water, the supplies of these materials are being rapidly depleted, and, although the problem at present is far from urgent, they may eventually be entirely used up.

For many years scientists have realized the need of developing a new source of fuel and have been considering the possibility of employing the vast amount of energy which is constantly being received from the sun. The earth and its atmosphere intercept the equivalent of 21 billion tons of good coal per hour, which means that in three minutes enough energy is received to equal America's consumption for one year. In the past, many devices have been built in an attempt to tap this immense flow of power, yet the results of these early experiments have been unrelated and undecisive. These inventions worked with varying degrees of success, but, until two years ago, when Dr. Godfrey Cabot's gifts to Harvard and the Massachusetts Institute of Technology made possible the establishment of research programs at the two schools, no scientific inquiry into the basic problems of solar energy conservation had been made. The Harvard group is primarily concerned with an investigation of the chemistry of photosynthesis, while a committee of the Institute is studying the physical problems of energy collection and utilization.



Sectional view of solar energy building described in the text

Before proceeding further with a discussion of solar power perhaps it would be well to destroy the optimistic picture which is given by the above figures of the amount of solar energy available. They are based on the amount received per acre of surface at a point outside the earth's atmosphere and normal to the sun's rays, which energy at noon reaches a total of about 7500 horsepower. Of this power only about 5000 horsepower reaches the surface of the earth. If this energy is used to operate a heat engine, allowance must be made for the efficiency of collection as heat in a fluid, and the energy rate drops to 3300 horsepower. Taking the highest attained value for the efficiency of converting such heat to useful power, the horsepower becomes only 490.

Thus far the calculations have been based upon sunlight normal to the surface of the collector. If the collecting system is mounted to follow the sun, in order to fulfill this condition, the different units of the system must be separated so that they do not shade each other during part of the day. Allowing a ground coverage factor of one third, the horsepower is cut to 163. Converting this figure to power over a 24-hour period in summer in Arizona, the output becomes 83, or in winter 68, horsepower. Finally, considering the average number of clear days in New York the actual horsepower per acre is 50, only one 150th of the initial figure.

One may evaluate this answer in terms of dollars and cents and hence roughly determine the economic feasibility of employing solar power. Assuming that electrical power can be produced in a large modern plant at 6 cents per kilowatt hour, or $53 per kilowatt year, the output of a one-acre plant is worth $1900 a year. Figures on labor costs and maintenance are lacking, but optimistically assuming a high capitalization of 15 percent, there is $13,000 to spend on the entire plant, or $2.60 per square yard. As ground coverage was only one third, $8.00 is available to construct each square yard of reflectors, mountings, and accessories. This value is quite low and shows how slim the margin of profit is at present on a solar energy plant. It is evident that the degree to which solar power is to be utilized in the future depends upon the increase of these efficiencies, and it is toward this end that the research is being devoted.

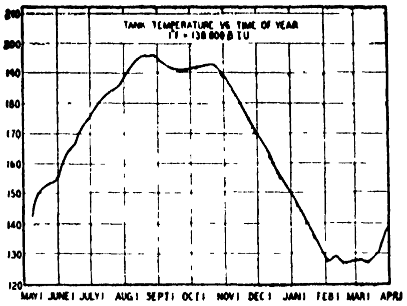
The first project in the solar research program at Massachusetts Institute of Technology is the study of different types of collectors and the development of one with the highest possible efficiency. The type of collector which has been perfected to the greatest degree is the simple, flat-plate type. It consists of a sheet of metal, or a body of some other material such as water, sulfur dioxide, or even sand which is heated by the sunlight. The bottom side of the plate is insulated and the top side is covered by a sheet of glass parallel to it with about an inch of air space between. When thus covered,

Courtesy *The Tech Engineering News*

the plate receives practically as much sunlight as before, the glass transmitting about 90 percent, but the losses from the plate to the atmosphere are greatly reduced, the convection losses being eliminated due to forced stagnation of the air, and the radiation losses being eliminated because the glass, although transparent to the sun's rays, is opaque to the long-wave infra-red radiation emitted by the hot plate. Variations in this design include the provision of vacuum spaces instead of dead air spaces, and employing several glass plates instead of one.

As each additional layer of glass cuts down the losses, one would suspect that with sufficient layers a perfect collector could be built, yet this is not the case. It is true that if the right glass is chosen there will be little absorption of the sunlight, but there is a reflection loss of about 4 percent at each surface. Consequently, as one adds more plates, one ultimately reaches a point where the reduction in heat loss from the metal plate is more than offset by the reduction in intensity of incident radiation due to reflection losses. This optimum number of plates varies, being less the greater the heat from sun and more the colder the weather or the hotter the collecting plate.

It was in order to decrease these losses through reflection that the process of coating glass was developed by Dr. Turner and Dr. Cartwright whereby the glass has a permanent surface of reflectivity approaching zero at one point of the spectrum. This important discovery has already proved valuable in many other fields, ranging from spectacle lenses to bomb sights. As yet the special glass has not been used in an experimental solar energy collector, but calculations indicate that its use should make possible the attainment of 800 degrees, Fahrenheit, without the use of mirrors, lenses, or other concentrating devices.



Yearly chart of tank temperature

A second problem in designing flat-plate collectors is that of optimum tilt. Because of the simplicity of the design, it is more economical to have the collectors mounted at a permanent tilt than to have them follow the sun. The angle of tilt depends very definitely on the use to which the collected heat is to be put. If the purpose is the maximum collection of heat during the entire year, tilting should favor the summer months. If, however, the object is to supply heat for a load which varies during the year, the tilt should favor the part of the year during which the load is the greatest.

Sun laboratory where the plan to heat a building by solar energy is tested

Of the many uses to which such collectors may be put, perhaps the simplest is the heating of a house in a relatively cold but sunny climate. The system would consist of a well insulated tank from which water can be pumped to the collector and back whenever the collector is hotter than the tank, and a set of radiators through which the hot water could be circulated to heat the building. It was for research into this type of heating that a testing cottage was built on the Massachusetts Institute of Technology grounds. For many months the plan has been put to a practical test, and valuable data are being obtained on the optimum number of glass plates, the best tilt, the ratio of roof to tank area, and the advisability of employing special types of glass.

Another obvious use is the employment of the sun's heat to run a steam engine, a hot-air engine, or similar device which requires a heat reservoir. The cost of power production in a conventional plant depends enormously upon the size of the plant, and, therefore, although the efficiency of solar power plants is small compared to large conventional plants, it nearly equals the efficiency of very small plants. It is not unreasonable to hope that future large solar energy converters will make power as cheaply as a fuel-fed plant.

In order to obtain efficiency in small solar plants, another type of heat engine is being developed—the thermopile. When two dissimilar, conducting materials are joined to form a loop and the junctions kept at different temperatures, heat flows into the loop at the hot junction, a portion of its energy is converted into electrical energy, and the rest flows out as heat at the cold junction. This principal of thermoelectricity has long been known, and the possibility of electrical power production on a large scale by this method has often been considered and always dismissed because the effect is very small. As the result of recent research, the overall efficiency of the best thermopile is about 4 percent, but it is possible that intensive research will increase this value several fold. As the efficiency of the best steam power plants is only 25 percent, a small converter with an efficiency of 5 percent would be of great value. It is toward the development of more effective thermopiles that the second branch of the research program is directed.

In order to form an effective couple, the two metals must have, in addition to high thermo-electric power, a low thermal conductivity in order to minimize the loss of heat flowing from the hot to the cold junction, and a high electrical conductivity so that there will be low resistance losses. The ratio of thermal to electrical conductivity is known as the Weidemann-Franz ratio, and it is desirous to have this value as low as possible. Experiments have shown that alloys of zinc and antimony have a surprisingly low Weidemann-Franz ratio while retaining a high thermo-electric power. By using an alloy of 43 percent zinc in antimony against a Copel alloy with a temperature difference of 400°, Centigrade, a moderately effective engine is formed.

Thus far, only the so-called heat engines have been discussed. Both steam engines and thermocouples are devices which receive energy at a certain temperature, convert part of this energy to useful power, and throw away the rest to a so-called heat sink at a lower temperature, and, therefore, their efficiency is limited by the Second Law of Thermodynamics. It is this law which states that the efficiency of a heat engine cannot be greater than the difference of the initial and final temperatures divided by the initial temperature; that was the reason for the sudden reduction of the value of solar power from 3300 to only 490 horsepower. As high efficiencies are thus impossible if only the heat from the sun's rays is employed, scientists have been examining other properties of this radiation in the hope of finding other more profitable methods of power conversion.

It has been found that the light quanta are able to knock electrons out of atoms or atomic lattices in crystals and produce an electric current, a phenomenon known as photo-electricity. This property of light is employed in camera exposure meters in which the current generated moves a galvanometer needle, and thus measures intensity of illumination, and it is the project of the third branch of solar research at Massachusetts Institute of Technology to see whether this same method is applicable to large scale current generation.

THE light-sensitive unit of such a device is known as a blocking layer photo cell, of which the copper oxide cell is typical. It consists of a massive plate of copper which has been oxidized on one side and then etched, thus producing a layer grading from cuprous oxide through all proportions of oxygen down to pure copper. The cuprous oxide surface is coated with a very thin layer of some other metal, so thin that it is transparent to light quanta. A light quantum, on hitting the cell, passes through the metal cover and the cuprous oxide into the layer of composition varying between copper and cuprous oxide, the so-called blocking layer. Here it succeeds in breaking an electron away from the crystal lattice, and this electron finds it easier to migrate toward the copper than through the copper oxide to the metal film. This unidirectional motion of the electrons constitutes an electric current.

How important is this phenomenon in generating power from sunlight? Quantitative experiments have shown that of the visible light quanta falling on a cell only 5 percent succeed in freeing an electron, and that the voltage efficiency is about 10 percent. The overall efficiency is, therefore, only .5 percent, but, as in the thermocouple, it is possible that this efficiency may be increased as much as tenfold. Such an accomplishment will not be easy, however, for physicists actually know very little about what goes on in the blocking layer of a photo cell. In order to supply these data, a research project is being initiated in the Electrical Engineering Department in connection with a broad program of study of insulators and semi-conductors, from the viewpoint of atomic physics.

THE last of the Massachusetts Institute of Technology solar energy projects, like the one just discussed, depends upon the special properties of sunlight rather than on its overall energy content. Everyone is familiar with the basic action in plant leaves whereby carbon dioxide and water are converted into carbohydrates and oxygen by means of sunlight in the presence of the catalyst chlorophyll. If man were able to copy nature and utilize light to produce substances of high energy content, a vast supply of power would become available. This does not mean that research should necessarily be directed toward reproducing photosynthesis in the test tube, but rather it should search for the necessary catalysts and conditions which would allow one to carry out some simple energy-storing reaction like the decomposition of water. A major problem would be to devise a reaction with suitable intermediate steps, in order that the small energy quanta of which light is composed could be employed one step at a time, just as nature undoubtedly does in the leaf of green plants.

Research at Massachusetts Institute of Technology, however, is approaching this problem somewhat differently. Rather than attempt to produce a stable product of great energy content, such as fuel or explosive, one may attempt to capture the energy of the intermediate products and convert it into electricity. It is necessary to find a photo-chemical reaction in which the passage from an unstable to stable state can be made to proceed as the electrode reaction in a cell. Such an oxidation-reduction reaction which is now being carefully studied consists of an organic dye, thionine, and ferrous iron in the form of a ferrous sulfate solution. The reaction can be represented in the following reversible equation.

$$\text{dye} + \text{Fe}^{++} = \text{leukodye (colorless)} + \text{Fe}^{+++}$$

FERRIC iron is a much stronger oxidizing agent than thionine; therefore, in the dark, all the thionine is in the form of the dye, and the iron in the reduced state. If the mixture is exposed to light in the range absorbed by thionine—visible light from 5000 to 7000 angstroms—the thionine molecules become capable of oxidizing ferrous iron. As the leuko compound is colorless, the reaction can be followed by watching the decolorization of the solution. This is the most light-sensitive reaction which has yet been discovered. As the composition of the solution changes by illumination, its electrode potential also changes. If two platinum electrodes are placed in the solution and one is illuminated and the other kept dark, a potential difference is established and a current flows from the dark to the illuminated electrode.

There are two qualities of such a cell which must be determined if its industrial importance is to be ascertained: first the electromotive force produced by a given light intensity, and second the current which may be drawn from the cell. The variations in potential with intensity of light, with different concentrations of thionine and iron, and with solutions of different *pH* have been studied and optimum values determined. In order to produce power efficiently, the cell must be able to give a strong, steady current, but whether or not such efficiency can be hoped for it is too early to say.

Thus research on converting the sun's rays to useful power has only begun. Latest advances indicate that the likely fuel supply of the future is sun.

• • •

FUNNELS

Stainless Steel Saves Over Four Tons Per Stack

DESTROYERS—often referred to as the "greyhounds" of the battle fleet—are required to operate on a comparatively low displacement, so that they can readily attain the high speeds essential to their effective use. Every ton of material that goes into the structure of a vessel of this class of warship, consequently, is given careful consideration.

Just recently, for example, it was announced that the United States Navy's newest destroyers will carry stainless-steel funnels. These funnels are said to be 4½ tons lighter than the type used on destroyers built in previous years. This means that additional armor, guns, and torpedoes can be carried.

Even though the sections of metal used in these funnels are relatively thin, the resulting structures are remarkably sturdy because of the high strength of the stainless steel, their welded construction, and the fact that adequate reinforcement is provided by corrugated stiffeners. The metal's resistance to the corrosive action of salt air and exhaust fumes, and its resistance to shock, should also provide added safely under stresses to which they will be subjected when placed in naval service.

REFRIGERATED

Containers for Express Shipments

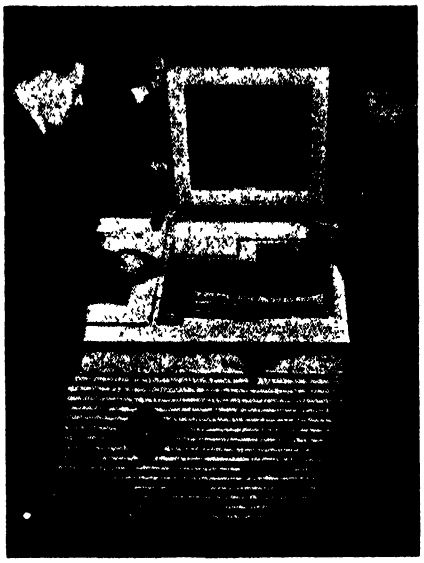
A marked increase in variety of perishable commodities moving in its "refriger-ex" service has been noted recently by the Railway Express Agency; the system involves the use of refrigerated containers especially designed for less-than-carload-lot movement in express service.

The boxes, which are mounted on casters for easy handling, permit inside temperatures from below zero to levels above the freezing point and upwards. Dry ice is employed as refrigerant for extremely low temperatures and regular ice for those of more moderate ranges. Quick-frozen foods and some serums, vaccines, and medical supplies usually require below-zero facilities of the container.

The greatest traffic increases in the field, however, have been for products calling for water ice refrigeration. A number of containers, for example, are assigned to the movement of blood donations, in hermetically sealed bottles, from Red Cross stations in large cities to the processing plant in each area, for the production of dry plasma transfusion units.

In transit

The Church container is also being used on an expanding scale by large oyster shippers at Chesapeake Bay points, in getting the shucked product to dealers over a wider area. Fifty two-gallon cans can be placed in a container, making a shipment load of 418 pounds.



With portable display top

The containers have likewise been found advantageous for LCL express movement of ice cream, dressed poultry, frozen foods, fruits, vegetables and seafood, meat, hatching eggs, and a miscellany of other perishable products including serums, laboratory specimens, and unexposed motion picture film stock. When they arrive at their destination they may be equipped with a portable glass top, enabling consignees to use them as refrigerated display cases, paying only a nominal fee for retaining the boxes as long as needed.

TRUCKS

Urged to Replace Railway Mail Service

Establishment of additional highway post office routes as substitutes for abandoned railway service is recommended by Smith W. Purdum, second assistant postmaster general. Efficiency of such routes is evidenced by the fact that three highway mail routes, using specially built trucks, were established about a year ago by congressional authority to substitute for abandoned railway mail service between Washington, D. C., and Harrisonburg, Virginia; South Bend and Indianapolis, Indiana; and San Francisco and Pacific Grove, California.

LIGHTNING

Continuing Studies Trap Biggest Bolt

Bolts of lightning hurtling down twin copper cables on a smelter stack 30 feet taller than the 555-foot Washington Monument, have been studied for science by engineer-detectives in Anaconda, Montana. One bolt was the most powerful direct stroke of lightning ever recorded. Its current totaled more than 160,000 amperes.

This investigation is part of a nationwide effort to learn more about lightning, hence more about how to protect power lines and electrical apparatus from damage and resulting inconvenience or loss to power users.

Sponsor of the study is the Westinghouse Electric & Manufacturing Company, whose research engineers developed the "fulchronograph," a device which enables accurate measurement of the intensity and duration of lightning strokes. Co-operating in the work are engineers for the Anaconda Copper Mining Company and The Montana Power Company.

"Current in the most powerful bolt recorded probably totaled about 200,000 amperes," W. E. Lee, Westinghouse representative, said. "Unfortunately, range of the measuring device was only 160,000 amperes. Needless to say, capacity of the instrument was increased to 200,000 amperes immediately."

Although voltage of the stroke was not measured, it is estimated that approximately 15,000,000 volts would be required at the top of the stack, to cause the fulchronograph to register 160,000 amperes at the bottom. Momentary energy of the stroke probably totaled nearly two and one-half billion killowatts.

If such an immense amount of energy could be produced steadily at some gargantuan power plant, output of that plant would be approximately 57 times greater than the total installed capacity of all the nation's generating stations. Total installed generating capacity of U. S. power plants was 42,435,863 kilowatts as of June 1, 1941.

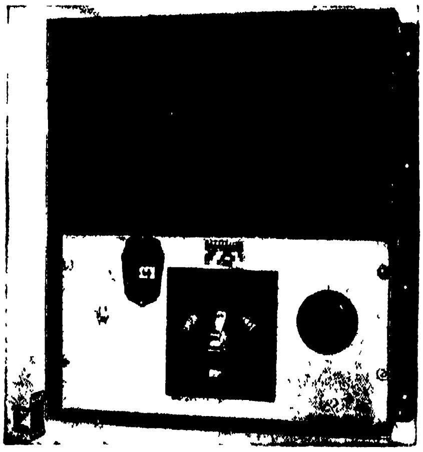
"Bait" in the lightning "trap" at Anaconda comprises 20 vertical one-inch copper rods, five feet long. Mounted in a copper ring 60 feet in diameter which encircles the top of the stack, these rods extend skyward like spikes on a coronet. Each spike is coated with lead to protect it from hot flue gases, and tipped with hard metal alloy to enable it to resist destruction as a bolt strikes. Two copper cables connect the ring atop the stack to the fulchronograph, which is installed in a small building at the base of the stack. Essentially, the fulchronograph comprises an electric motor and a slotted aluminum wheel, the rim of which is filled with small strips of magnet steel projecting like fins and rotating through two coils. The coils carry current from the lightning stroke being measured.

Current in the coils produces a magnetic field which is proportional to the surges of lightning current. The steel fin on the recording wheel which happens to be passing the coils at a given instant is magnetized in proportion to the amount of current carried by the stroke, in time divisions as brief as 40 millionths of a second. Characteristics of the stroke may be determined by the number of fins magnetized, and the degree of magnetization.

COIL TESTING

Quickly Done With New Machine

Coil testing machines, for quickly determining all of the electrical properties of a coil in one handling, are now available for checking the limits of insulation resistance, coil resistance, effective A.C. resistance, inductance, and shorted turns, as well as for checking effective turns, direction of windings, and other important properties. There are two types of machines: automatic and semi-automatic, each having holders adapted to the special shapes of coils to be tested.


Eleven tests, quickly

One of our photographs shows a machine of the semi-automatic type, capable of making eleven tests in quick succession on each coil, and checking up to 250 coils per hour. In using this machine the operator attaches the coil to holder at center of panel, pushes terminal wires into spring clips, and turns the large knob one step at a time. The design is such that at each step the pointer of the illuminated galvanometer must cross the center of its dial by moving from left to right, or from right to left. The operator watches for this movement; if it occurs, he knows that the coil has passed that test. If the pointer does not cross the center of the dial for some one test, then the nature of the defect in that coil is shown by lettering on the knob.

PAINT STRIPPER

Heats and Scrapes With Same Unit

An electrically heated tool which heats painted surfaces and wet wallpaper surfaces, and then permits the operator to scrape the surface with the same unit, can be operated on any conventional 110 volt A.C. or D.C. circuit. This new device, manufactured by the Heating Equipment Company and illustrated in one of our photographs, has a flat heating surface. When used for removing old paint or wallpaper which has been wetted, the heating surface is applied and drawn over the paint or paper. A prompt forward thrust of the scraping edge cleans the surface of paint or paper, stripping it off without burning.

Pull . . . push, to remove paint

The square scraping plate is regrindable or replaceable and has four interchangeable sharp edges. It is claimed that the heat from the unit keeps the scraper plate clean.

WAR GASOLINE

Sold to Public Contributes to Aviation Fuel

Automobile owners are contributing to the huge stock of high-test aviation gasoline with which the United States proposes to win the war. This contribution is being made in a new war-time motor gasoline, now being sold at most gasoline stations, according to Robert H. Colley, president of The Atlantic Refining Company.

"The new war-time gasoline starts just as easily on a cold morning, and in most automobiles will give just as good performance and yield just as much mileage. For that reason 95 percent of the automobile owners will not notice that there is a difference between it and the gasoline they used to buy at the service station on the corner," Mr. Colley explained.

"All gasoline blends are a complex mixture of petroleum compounds. Part are found naturally in crude oil. Others are products of the 'cracking' process. Some have a fairly high octane rating. But usually other substances have to be added to give the blend a sufficiently high anti-knock value. In most cases tetraethyl lead is the substance used. In others additional high-octane petroleum products are added.

"Both these added substances are needed by the government to assure adequate reserves of aviation gasoline to meet any possible emergency, and to obtain the amounts required, the precious tetraethyl lead supplies have been rationed and the high-octane petroleum products requisitioned.

"In order to produce a gallon of high-test aviation gasoline it is necessary to strip 16 gallons of motor gasoline of these high-octane components. To this is added a petroleum hydrocarbon of very high octane value, manufactured from one of the choice components stripped from motor gasoline. Then a final small dose of tetraethyl lead is used to bring the fuel up to the 100-octane mark.

"That explains the difference between the motor gasoline now being sold and that sold a few weeks ago. That difference represents the motorists' contribution to keep American planes flying and help win the war."

BOMBER-FIGHTER

New Dual-Purpose Plane Used by British

A new airplane with a dual personality—fighter as well as bomber—has enabled the British to develop a technique of bombing entirely new even among the novelties of modern aerial warfare. In a day when new planes are being equipped with superchargers to cruise in the heights of the substratosphere, this latest air weapon hugs the ground and even dips into hollows or ravines to hide from enemy fire.

While most bombers are heavy, lumbering craft requiring for protection convoys of fast fighters or the shelter of high altitudes and masking clouds or darkness, these new ships need no escort and make no attempt at high-altitude flying. With military experts pinning their faith on intricate bomb-sights, these pilots use no aiming devices at all, according to *Science Service*.

Machine-gun "strafing" from low altitudes is something European fighters have been familiar with since the days of World War I. Dive bombers are by now taken for granted. But this new sort of "horizontal bombing" from planes grazing the tops of the hedges, and whizzing by at 340-mile-an-hour speed, has provided the Germans with a complete surprise.

The British journal *Flight* reports it as fact that the Germans are building 30-foot anti-aircraft towers in order to be able to shoot down on these new bombers.

The new technique has produced its own problems in ballistics. When a bomb hits the ground from such a low height, it ricochets along the ground horizontally and hits the target from the side instead of from above. This is all right for a huge target. But one pilot who watched a companion attack a railway station reports that the bombs went clean through both walls of the station and exploded harmlessly some 300 yards away.

The airplane is in some danger from its own bombs at such low altitudes. In order to be reasonably safe from the explosion of a 250-pound bomb such as those carried by the new Hurricane, an airplane must be at a greater height than 1500 feet—2000 feet would be better. To get around this, delayed-action bombs that do not explode on impact are being used, and formations have abandoned their sentimental attachment for the V symbol in favor of flight abreast. If one plane flew behind the others, the last man would be blown up by the bombs dropped by the leader.

The regular procedure has been this. The planes cross the channel flying in formation at economical cruising speed. As soon as the coast of France is reached, they throw the throttles wide open and zip across country at full speed. some 500 feet per second. At this speed anti-aircraft fire finds them a very difficult target, and they have approached, passed, and gone before interceptor planes can leave the ground.

The two bombs carried by each plane are both dropped at one time, some distance from the target to allow for the tendency to ricochet along the ground in the direction of the plane's flight. Before their bombs explode, the bombers are already away—and no longer bombers. With their loads discharged, these dual-personality aircraft become fighters with all the speed and maneuverability for which the Hurricane is famous, capable of dealing with any interceptor planes.

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TRACTORS—Not more than 22 percent of all farms in the United States have tractors, but about 66 percent of all farms of more than 100 acres have them.

● ● ●

PARTS CONTAINER

Plastic Unit Holds Parts Visibly in Compartments

Originally designed for holding fishermen's flies and bugs, small transparent boxes have found an even wider application in industrial and other uses where they are employed for holding small parts. Made of plastic, they are available with a variety of compartment shapes so as to be applicable to various types of parts.

Small parts can't hide

These transparent plastic boxes, made by the Shoe Form Company, make it easy to check stocks of parts without opening the box and, since the partitions also are transparent, there are no dark corners where small screws and parts can get lost.

FLUORESCENT LAMPS

Now Available in Small Sizes

Two new sizes recently added to Hygrade Sylvania Corporation's fluorescent lamp line are the six-watt and eight-watt lamps. These small members of the fluorescent family are designed for supplementary lighting purposes; for example, for instrument panels, in counter lighting, and over machinery. They are also suited for use in bed lamps, pin-up lamps, desk lamps, and for artistic direct or indirect illumination of mirrors, pictures, walls, and so on. The six-watt lamp is nine inches long and the eight-watt lamp is twelve inches long. Both are ⅝ of an inch in diameter. They are made in two colors —3500° white, and daylight—and have an average rated life of 750 hours.

Six watts, eight watts

CELLOPHANE BAGS

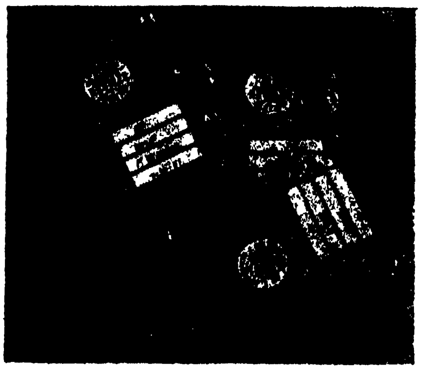
Find Uses in Varied Industries

The famous Warner & Swasey lathes, now in great demand for armament work, come down the assembly line just a little smoother and faster because of Cellophane bags. All smaller parts are tagged with a part number in the stock room, then loaded into Dobeckmun Cellophane bags. This keeps them intact, yet fully visible to the operator, who does not have to open several containers before he locates the right one.

Since there are between 5000 and 9000 individual parts in a turret lathe, a good job of housekeeping and of control is needed to assure delivery to the assembly floor of all the parts when called for. The transparent bag system has been in effect nearly a year and, according to Warner & Swasey officials, is working out very satisfactorily.

Another use for similar bags, this time with printed panels on the bag faces, has been found by the Leece-Neville Company for the packaging of repair parts. Some fifty different automotive parts are packed in these bags The white panel on the face of the bag is printed with a special ink which permits easy marking with pencil, crayon, or rubber stamp.

When a bag is packed, the count, part number, and customer's order number is written on the bag. This,



Transparent bags, easily labeled

plus the transparency of the Cellophane simplifies "checking in" the order when delivered to the customer. It also simplifies inventory and reordering as the contents of each bag can be checked without opening the bags or removing the parts.

STEELS

Developed in Peace, Used in War

Many special steels originally produced by the steel industry for everyday, peace-time uses such as automobile bumpers, carpenters' hammers, and piano strings, are now being used in large tonnages in the manufacture of machine guns, tanks, armor-piercing bullets, other implements of defense.

Because the steel industry long ago learned how to make those steels well and in large quantities, it was able immediately to adapt its experience to the urgent needs of the national defense program.

Among the many commercial steels now serving for defense is an alloy steel containing about 1.5 percent nickel and somewhat less than 1 percent chromium. Developed originally as a steel for axle shafts of heavy-duty trucks, today it is used in the tread mechanisms of tanks where service conditions are even more rigorous than in trucks.

Another alloy steel with about 1 percent chromium and 0.1 percent vanadium, is found in almost every home workshop in the country in the form of a hammer or some other hand tool. It is also to be found today as the steel from which the cocking lever pin of a machine gun is made.

A plain carbon steel containing about 0.8 percent carbon, has long been used by automobile manufacturers for the manufacture of bumpers. A springy steel, it can stand a lot of punishment before crumpling up or breaking. Those same qualities are useful today in the locking mechanism of machine guns. Another important part of machine guns is the firing mechanism which is actuated by a steel spring made from exactly the same kind of wire that is used to make piano strings.

In adapting these and other steels from commercial to defense applications, steel metallurgists frequently prescribe changes in heat treatment and fabrication procedures. These changes are ordinarily made to produce physical properties different from those usually found in the steels.

Basically, however, a large number of the steels which today are building defense material are the same as those from which are made automobiles, pianos, bridges, washing machines, and the multitude of other peace-time products of American industry.—*Steel Facts.*

NITROGEN WELL

Discovered While Drilling for Water

Pure nitrogen gas flows from a recently drilled shallow well on a western ranch, Harold Cook, consulting geologist of Agate, Nebraska, reports in *Science*. This is believed to be the first nitrogen well ever struck. The well was being drilled for water, Mr. Cook says, when it began to yield gas at a considerable pressure at a depth of only 156 feet. A sample sent to the laboratory of the United States Geological Survey for analysis was found to be composed of 100 percent nitrogen.

Since an apparently large supply of pure nitrogen, all ready to use, may have value in the present war emergency, the new-found well has been shut down to conserve the gas until the best possible uses are developed.

FULGURITES

Made Artificially, Using "Hot" Lightning

Engineers at the Westinghouse high-voltage laboratory recently caught man-made lightning in a bucket of sand to produce replicas of the glass-like fulgurites formed by natural lightning strokes. "Since a temperature of about 3000 degrees is required to melt sand into fulgurites, these experiments give us definite knowledge of the tremendous heat which lightning can produce," Dr. P. L. Bellaschi, directing the experiments, reported.

"Fulgurites might be called petrified lightning," the investigator explained, "since they have the same crooked shape as the bolts that formed them. Natural specimens occasionally are found buried in the ground, particularly in dry desert sands. They are glass-like tubes of solidified sand, formed when lightning surges through dry earth in search of moist ground to neutralize its charge."

Because of the scarcity of natural fulgurites, the Westinghouse lightning engineers have shipped their first collection of artificial specimens to the Chicago Museum of Science and Industry and are now preparing a second collection for the Franklin Institute in Philadelphia.

Man imitates nature

"Natural fulgurites are discovered rarely, because conditions must be just right for their formation," continued Dr. Bellaschi. "The sand must be of the proper composition to melt into the glass-like formation. And it must be struck with 'hot' lightning—a type that lasts longer than average strokes. Only a small percentage of the strokes is of this hot variety. Also, since fulgurites are concealed in the ground, they are discovered only by accident."

In the manufacture of artificial fulgurites Dr. Bellaschi used pure quartz sand, plus a small amount of feldspar sand to make the quartz melt more easily. The sand was packed firmly into a container about two feet tall and the end of an electric conductor from the "lightning maker" was stuck into the sand.

Then the generator was set to deliver a hot lightning discharge of 1000 amperes. In a hundredth of a second the artificial stroke bored its own path through the sand and heated the walls of this hole white hot, forming the fulgurite.

"A hundredth of a second is a long time for a lightning stroke to last," the investigator commented "Some of nature's bolts, as well as those produced in our laboratory, last only a few millionths of a second. Such short strokes are known as 'cold' lightning, since they do not last long enough to create great heat in the substances through which they pass. However, they do ex-

How A Big Business Man Appears To His Wife

"LOOK at him over there, grinning to himself! Strange how little a man can change in fifteen years! The big boss one minute—and like a little boy the next!

"He was mostly 'little boy' before we were married. He'd been coming around for a couple of years, and I'd just about given him up. Then, suddenly, he was very much a *man*, rushed me off my feet and almost before I knew it, we were married.

"When we were newlyweds he was only a bookkeeper, and he'd come home in the evening all tired and discouraged. Other fellows at the office had been promoted, and he didn't know what to do about it. One night I forgot myself and said, 'If *you* don't do anything about it, Mr. Stick-in-the-Mud, no one else ever will!' Then I was sorry, when I saw how I'd hurt him.

"But it must have made him think hard, because one evening the following week he came home looking as though he'd just robbed the piggy bank. He told me he'd enrolled for a course of executive training. He thought I'd be angry, because we were still paying for the furniture. The 'little boy' and the man, all mixed up!

"After that, his whole point of view toward business seemed to change. One promotion followed another, until a few years later he became Treasurer of the company. Now he's beginning to surprise me. Says he expects to be Vice President soon!

"Of course, he's just as modest as he ever was. He'll tell you he got the breaks, but I know better. He *got* the breaks because he'd learned how to grasp them when they came. He's really smart—and so was I when I said 'I do' to a little boy turned man!"

• • •

What does the lady in *your* life think of *your* success? Get more of the Alexander Hamilton Institute's story in the famous little book, "Forging Ahead in Business." Tells how the Institute's timely training is helping thousands of men to do a better business job in these wartime days. Just clip and mail the coupon—today!

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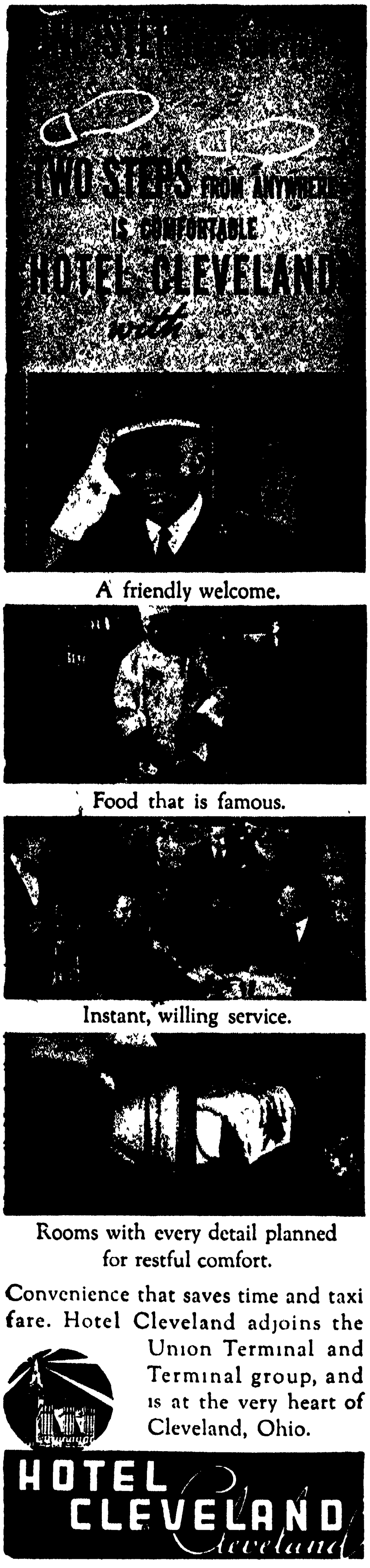

A friendly welcome.

Food that is famous.

Instant, willing service.

Rooms with every detail planned for restful comfort.

Convenience that saves time and taxi fare. Hotel Cleveland adjoins the Union Terminal and Terminal group, and is at the very heart of Cleveland, Ohio.

HOTEL CLEVELAND
Cleveland

ert explosive forces, shattering telephone poles and trees, blowing earth into the air, and causing thunder.

"Since it lacks the explosive force of cold lightning, hot lightning does not cause thunder. It destroys quietly. Strokes of hot lightning sometimes last as long as a tenth of a second—long enough to set fire to wooden structures or melt sand, rock or power wires. Many natural lightning bolts have both hot and cold elements, and therefore can start fires as well as cause thunder."

PROTECTION

Liquid Coating For Brickwork, Metals

Designed for use on exposed surfaces in furnaces, kilns, incinerators, cupolas, and so on, a new liquid material available under the name of Helfyre can be painted over the surfaces of refractories as well as metals. The resulting coating protects against attack by slag, acids, and corroding elements at temperatures up to 3200 degrees, Fahrenheit.

SAWDUST

Serves as Fuel in Home Furnace

With new installations of gas-heating equipment prohibited, possible priorities on additional equipment for the use of fuel oil, and transportation facilities needed for the moving of war materials proper, it may be that Eastern and Southern house-holders, as well as those in the West, will soon be looking to America's abundant forests as a source of residential heat.

This would be no news to thousands of western home owners who live in the vicinity of the forest products mills.

Hopper-fed sawdust burner

For years chipped wood, mixed with sawdust, has been an important source of home heat in Tacoma, Seattle, Portland, and many other cities of Washington, California, Oregon, and Idaho. In fact, 25 percent of Seattle homes use such heating systems. The idea is applicable to other parts of the country because America's vast forest resources are scattered throughout the nation, and, for fuel, as well as in countless other categories, these resources can pinch-hit for war-scarce commodities.

Chipped wood and sawdust have proved to be a practical source of home heat, an economical fuel, and one which presents no fire hazard since sawdust is naturally damp. In the type of burner shown in one of our illustrations, the sawdust and chips drop from the bottom of a cone-shaped hopper into a burning grate designed for installation in an ordinary furnace. A hopper of sawdust will burn about 12 hours under normal conditions and provide plenty of heat with practically no ash.

• • •

FINE YARN—A type of yarn produced on ordinary textile machinery for making typewriter ribbons, airplane fabrics, and fine dress goods, is so fine that it takes 80 miles of it to make one pound.

• • •

PAGING SYSTEM

Can Also be Used for Private Conversations

Private two-way conversations between any two or more points, conventional paging through loud speakers, or telephonic conferences can be had by the use of a new paging system recently placed on the market by Executone, Inc.

Each station of the system comprises a hand-set telephone and a loud speaker; any number of assemblies between two and 70 can be installed in any one system. The stations are connected through a branch to a six-conductor cable leading to an amplifier connected to any 110-volt A.C. source.

In operation, a call is made from any station, the caller merely talking into the mouth piece of the hand-set while holding the paging button depressed. The name of the party being called thus issues from the loud speakers at all stations, and in addition, a signal light shows at each hand-set box. To answer, the person called lifts the hand-set at the nearest station and private two-way conversation is established.

Answering a call on paging system

All loudspeakers are then automatically silenced.

For conference work, the person calling a conference pages the names of all men with whom he wishes to confer. These men then go to the nearest station, remove their respective hand-sets, and all stations are interconnected for conference work.

In addition to these uses, this system is being applied to broadcasting general messages to all departments.

ARMOR-CRASHING

Bullets X-Rayed by High-Speed Tubes

First X-ray pictures of bullets as they crash through steel armor-plate are being taken by Army laboratory technicians at Frankford Arsenal. Twin X-ray units, each capable of delivering a charge of 300,000 volts in a microsecond (a millionth of a second) will be used for a series of Army studies of the action of bullets in flight within gun barrels and when they hit targets of armor plate or other materials. This research will be directed by Lt. Col. L. S. Fletcher, officer in charge of Frankford Arsenal Laboratory.

Although a bullet travels at 2½ times the speed of sound, the new X-ray photographic technique, developed in Westinghouse research laboratories, permits making two separate exposures during the flight of a single bullet. The two X-ray machines stand side by side, and the elapsed time between the two exposures can be varied from a five hundredth of a second to a millionth of a second. Two exposures can also be made simultaneously.

In the new ultra high-speed X-ray machine a series of six condensers and a power transformer are used. Drawing power from an ordinary 220-volt line, the condensers act as reservoirs, storing up electricity for nearly a minute. When the condensers are charged to a limit set by central controls, they send a jolt of 2000 amperes at approximately 300,000 volts to the X-ray tube. In the tube this energy is converted first into electrons and then a fraction of it to a tremendous surge of X-radiation which does its work in one-millionth of a second—almost as long as it takes a car, traveling at 60 miles an hour, to move a distance equal to a quarter of the thickness of a sheet of writing paper. An intricate timing device enables operators to fire the two machines quickly enough to get two exposures of a bullet before it has moved more than a few feet.

The first experimental tube which made possible ultra high-speed X-rays was developed in the Westinghouse Lamp Laboratories at Bloomfield, New Jersey, by Dr. Charles M. Slack and his associates. This tube generated the X-ray-producing electrons successfully for the first time without the aid of the usual heated filament. In tubes whose elements heat to produce electrons, speed of an exposure is limited to about one-hundredth of a second because the

THE NAVY "E" pennant flying over the Bausch & Lomb plant is official recognition of accomplishment in Production for Victory It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make

Awarded July [illegible] 1941

Miracle in a Quarter-Ounce of Glass

THIS is an ophthalmic lens, designed for the correction of vision. It measures 43x40 mm, 2 mm thick. It weighs 6 23 grams. Its refractive index is 1.5230, its mean dispersion, 0 00895 Its physical characteristics are matters of scientific fact, but they are no measure of the effect it may have on a human life

For, through the achievements of modern optical science, imperfect eyes are no longer a handicap. The school child, whose mind might otherwise have been dulled by faulty vision, today faces life undaunted, his eyesight defects corrected Business men, and housewives, go about their daily affairs with eyes equipped for today's tasks. Older men and women, reaching the age when their eyes can no longer accommodate for vision near and distant, need have no fear of loss of visual efficiency. Modern bifocal lenses, skillfully designed and fitted, restore comfortable youthful vision, extend years of useful working time to aging eyes.

So, in addition to its many contributions of scientific optical instruments for gunfire control, research and industrial production, Bausch & Lomb is filling a vital need as America arms for war. Workers with properly fitted glasses have vision of top efficiency. That means fewer errors in work, less fatigue, greater production.

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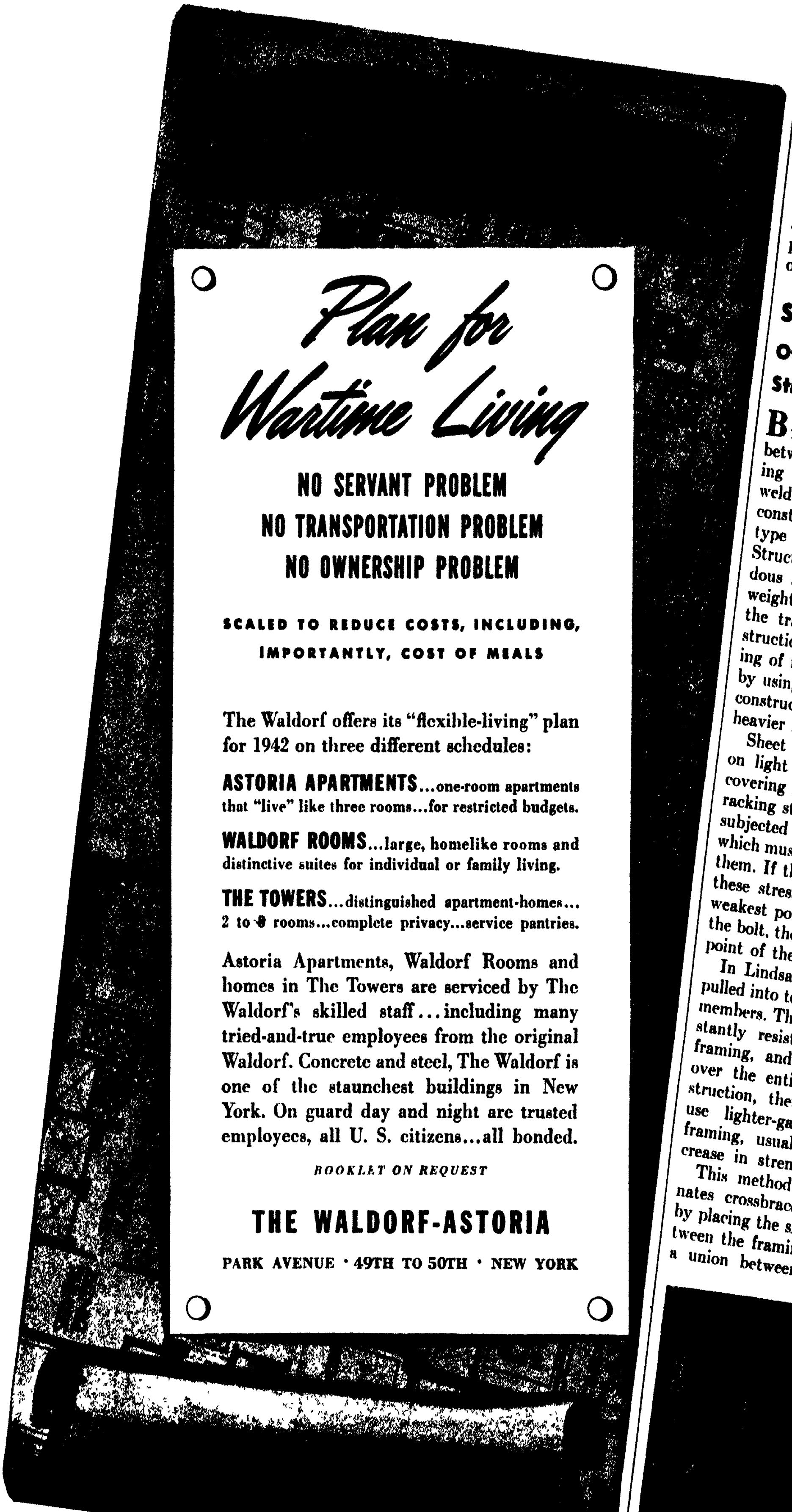
OPTICAL CO. • ROCHESTER, NEW YORK
ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION


Plan for Wartime Living

NO SERVANT PROBLEM
NO TRANSPORTATION PROBLEM
NO OWNERSHIP PROBLEM

SCALED TO REDUCE COSTS, INCLUDING, IMPORTANTLY, COST OF MEALS

The Waldorf offers its "flexible-living" plan for 1942 on three different schedules:

ASTORIA APARTMENTS...one-room apartments that "live" like three rooms...for restricted budgets.

WALDORF ROOMS...large, homelike rooms and distinctive suites for individual or family living.

THE TOWERS...distinguished apartment-homes... 2 to 8 rooms...complete privacy...service pantries.

Astoria Apartments, Waldorf Rooms and homes in The Towers are serviced by The Waldorf's skilled staff...including many tried-and-true employees from the original Waldorf. Concrete and steel, The Waldorf is one of the staunchest buildings in New York. On guard day and night are trusted employees, all U. S. citizens...all bonded.

BOOKLET ON REQUEST

THE WALDORF-ASTORIA

PARK AVENUE · 49TH TO 50TH · NEW YORK

power required to make any faster pictures would burn out the inner mechanism. The "cold cathode" principle removes the limit on the amperage that can be applied and hence can produce an enormously greater amount of X-rays.

STRESSED SHEETS

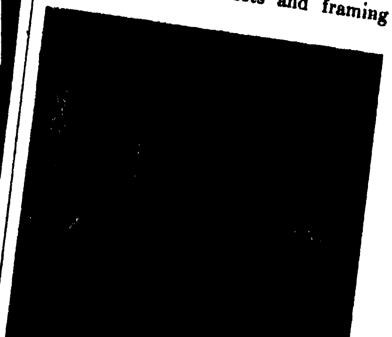
Of Steel Used in New Structural Units

By pulling steel sheets into tension between framing members and fastening them together without riveting or welding, a new method of structural construction has been achieved. This type of assembly, known as Lindsay Structure, is claimed to possess tremendous strength and to abolish needless weight. It is a definite breakaway from the traditional methods of steel construction and promises an annual saving of more than 100,000 tons of steel by using light sheet for many types of construction ordinarily requiring much heavier metal.

Sheet metal has been used for years on light structures—but simply as a covering material. Ordinarily, all initial racking stresses to which a structure is subjected are borne by the framing, which must be crossbraced to withstand them. If the framing begins to "wear," these stresses are concentrated at the weakest point of the sheets—the rivet, the bolt, the screw holes, or the tightest point of the weld.

In Lindsay Structure the sheets are pulled into tension between the framing members. These "pre-tensed" sheets instantly resist any movement of the framing, and the load is distributed over the entire area. With this construction, therefore, it is possible to use lighter-gage sheets and lighter framing, usually with a marked increase in strength.

This method of construction eliminates crossbraces, gussets, and struts by placing the sheets under tension between the framing members; it creates a union between sheets and framing



Stressed steel structure—strong

that approximates the full strength of the sheet; and it provides ease in assembly and disassembly from the outside, equivalent to the simplest bolted construction.

Many types of mobile structures have been fabricated with this new method. Motor truck bodies, bus bodies, railroad cars, and marine superstructures are some of the applications where light weight, tremendous strength, and rigidity are of primary importance. The system has also been used successfully in the construction of machine housings, industrial buildings, refrigerator lockers, farm buildings, portable shacks, garages, and other structures of diverse uses

GOLF BALLS

To Be Recovered for Further Use

A METHOD for re-processing used golf balls, developed to meet the war-time emergency, was announced recently by United States Rubber Company. Golfers are therefore urged to save their used balls.

It is claimed that the re-processed balls will look like new, except that they will be branded to indicate that they have been re-processed. They will have good playing qualities and will give service almost equal to new balls. The re-processing will be accomplished without using any materials on the restricted list

When balls are received for re-processing, they will be inspected and those balls which are out of shape, too old or too badly cut, will be discarded. The balls will be classified according to construction, the old covers removed, and new covers will be molded on the balls.

The cover will be of Tjipetir, a special form of Balata, and the new cover will be identical to the covers of new balls The re-processed ball will then be finished, painted, and marked with its proper brand name, depending on its construction.

Only the company's own brands will be re-processed by this method. Individuals are asked not to send balls to the company direct, because no provision will be made for this service direct to consumer. When the plan is put into effect, players will be asked to turn in their used balls to their golf professionals. They will receive a merchandise credit which they may apply either to the purchase of new balls, as long as new balls are available, or the purchase of "Re-Processed" balls. The pros will return the used balls to the company as sizeable lots are accumulated.

IMMEDIATE DELIVERY
LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS

	Inlet	Outlet	Price	With A. C. motor
No 1 Centrifugal	¼"	⅛"	$ 6.50	$25.00
No. 4 "	⅜"	½"	13.50	32.00
No. 9 "	1¼"	1"	16.50	35.00

← GEAR

No. 1⅛	Gear	⅛"	Price $ 9.00	With A.C. motor	$25.00
No. 2	"	¼"	" 10.00	" " "	27.50
No. 3	"	⅜"	" 11.50	" " "	28.50
No. 4	"	½"	" 12.50	" " "	32.00
No. 7	"	¾"	" 15.00	" " "	37.50
No. 9	"	1"	" 16.50	" " "	49 50
No 11	"	1¼"	" 48.50	" " "	on request

HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs A W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

Models S H G ¼

12" x 24" tank A C. 110 or 220 v. 60 cycle $57.50

16" x 30" tank A C. 110 or 220 v. 60 cycle $64.50

Large stock of air compressors, ¼ H.P. to 20 H P. A.C. and D C., all voltages, 1 to 120 C F M. displacement, built for all requirements. Additional data on request.

ATTIC AND INDUSTRIAL FANS

Belt driven, slow speed, exceptionally quiet in operation, highly efficient G E Motors

SIZE	H P.	R P M.	C F M	PRICE
24"	1/6	660	4200	$45 00
30"	1/6	540	5800	52 00
36"	1/4	415	8000	57 50
42"	1/3	390	11500	69 50
48"	1/2	360	16500	92 50

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An electrical device that converts ordinary oxygen into ozone Revitalizes and deodorizes the air. Suitable for laboratory, factory, office or home 110 volt AC Only 10 watts. $9.50

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Has Thermal Overload Device Positively dependable and protects motor in case pump stalls.

Capacity 3,000 gallons per hour with ¼ h p motor at low operating cost

Model B-2400 unit complete with 110 v. 60 cycle motor $37.50

Unconditionally Guaranteed for One Year.

Literature Sent on Request

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New Emerson 100th H P, 900 R P.M 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount, no base, Has many applications $7.50

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Sizes 7¾ x 12½ $3.25 each
Sizes 9¾ x 11¾ 3.50 "
Limited number of larger sizes on hand.

FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H P	R P M	CU FT MIN	INLET	OUTLET	PRICE
0	1/20	1750	160	4½"	3¾"	$22 00
0½	⅛	1750	350	6½"	3¾"	25 00
1	1/6	1750	535	6"	4½"	30 00
1¼	¼	1750	950	7½"	6"	37 50
1½	½	1750	1900	9½"	7"	75 00

PRICES QUOTED ARE FOR A C 110 V. 60 CYCLES ONLY.
OTHER VOLTAGES ON REQUEST

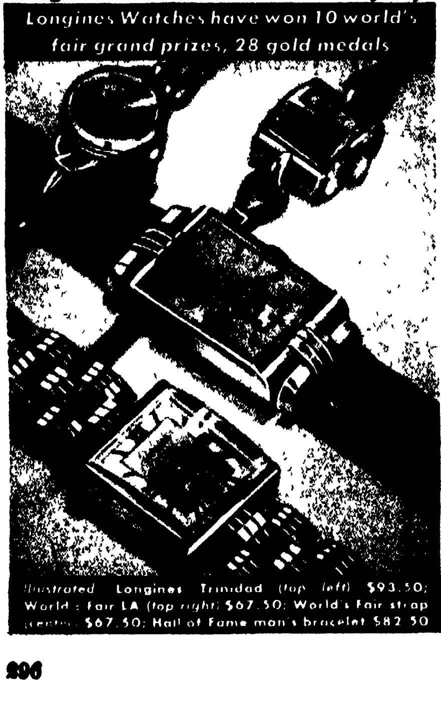
PIONEER AIR COMPRESSOR CO., Inc.
120-s CHAMBERS ST. NEW YORK CITY, N. Y.

This interesting looking watch, invented by Lieut. Comm P V H Weems (Ret), authority on navigation is the famous Longines Weems Second Setting Watch It can be used for serious navigation as well as casual time telling The Longines Weems in steel, $65

Longines

THE WORLD'S MOST HONORED WATCH

The unsurpassed technical and production facilities of the Longines factory are proved by the great accuracy of Longines aviation watches. These same fine facilities make all Longines Watches better watches. They keep good time for a longer time. Longines honors include 10 world's fair grand prizes and 28 gold medals. Longines-Wittnauer jewelers show the new Longines Watches; also Wittnauer Watches, a companion line of moderate price, from $29.75—product of Longines-Wittnauer Watch Company.


Longines Watches have won 10 world's fair grand prizes, 28 gold medals

Illustrated Longines Trinidad (top left) $93.50; World's Fair LA (top right) $67.50; World's Fair strap (center) $67.50; Hall of Fame man's bracelet $82 50

SUGAR

Shortage Has Its Good Health Points

Most Americans have too sharp a sweet tooth, and a little sugar rationing will do them more good than harm, according to diet authorities. M. L. Wilson, assistant director of nutrition, of the health and welfare defense program at Washington, for example, declares: "Sugar rationing certainly will harm no one. People will meet the restriction on sugar by adding calories from other sources—sources which contain vitamins and minerals lacking in our refined sugar."

Dr. L. H. Newburgh, University of Michigan authority on diet, advises: "Don't complain about sugar rationing; it will be good for you. As a matter of fact, it would be a Godsend if there were no sugar at all. For, if there weren't we would be forced to eat more grains, meats, milk, green vegetables, and other foods which give us everything that sugar does, plus much-needed B vitamins and minerals."

Dr. Newburgh points out that sugar's only importance to our diets is its fuel value, and this may be readily replaced by a host of other foods which provide more than mere fuel. Milk is the best fuel substitute for sugar, since it also provides proteins, vitamins, salts, and fats. One glass of milk, he says, is equal in fuel content to four teaspoonfuls of sugar.

Whole cereals are a much more wholesome food than sugar, since they provide, in addition to fuel, vitamins of the important B group and 10 percent of protein. An ordinary portion of oatmeal, for example, is equal in fuel value to four teaspoonfuls of sugar. Perhaps those who "have always intended to cut out sweets" will find the push from Uncle Sam helpful—*Science Service.*

BEWARE OF CADMIUM

Not Safe for Use in Food Containers

Evidence of a public-health hazard in the use of cadmium for plating food containers and food processing equipment, says the United States Department of Agriculture, adds interest to results of tests made some time ago by scientists of the Bureau of Agricultural Chemistry and Engineering and Stanford University.

Any cadmium-plated article coming in contact with food, particularly food with an acid reaction, reported the investigators—Wilson, DeEds and Cox—is likely to contaminate the food and to cause acute illness. Small quantities of cadmium taken in daily, the investigators reported, can produce anemia, enlargement of the heart, and bleaching of tooth enamel—a bleaching similar to the effect of fluorides.

Since efforts are being made to meet shortages of various materials, research of this kind is of high importance in insuring the public safe and sound substitutes. Cadmium is already branded as unsuitable as a plating substitute for containers or for food handling equipment.

ARTHRITIS

Linked to Childhood Rheumatic Fever

Evidence that chronic infectious arthritis in adults may have resulted from rheumatic fever in childhood is given by Dr. Archie H. Baggenstoss and Dr. Edward F. Rosenberg of the Mayo Clinic, according to *Science Service.*

The two Mayo physicians feel that arthritis involves more than disease of the joints; that it involves the vital organs, the crippled joints being merely one expression of this malady.

They examined the organs of 30 patients who had had chronic infectious arthritis and found evidence of disease in the heart, kidneys, liver, and other organs. There was damage to the heart in 24 cases and in 16 of these the injury was indistinguishable from that caused by rheumatic fever. Also significant was the pathologic condition discovered in the kidneys. It was felt that heart and kidney damage was due to the same underlying set of causes.

Drs. Baggenstoss and Rosenberg concluded there may be a relationship between chronic infectious arthritis and rheumatic fever, typically a disease of childhood.

SAFE PORK

Insured By Storage At Low Temperatures

Trichinae which cause the serious disease trichinosis, will not survive in pork treated by adequate freezing, according to the United States Department of Agriculture. The thickness of the cuts of pork or the inside dimension of the container determines the length of time the meat must be subjected to a given temperature to destroy any trichinae that may be present.

Pieces of pork or pork products not exceeding six inches in thickness must be stored for a continuous period of not less than 20 days at a temperature not higher than 5 degrees, Fahrenheit, or not less than 10 days at —10 degrees, Fahrenheit, or not less than six days at —20 degrees, Fahrenheit, to assure complete protection. For larger pieces or packages up to 27 inches in thickness, the storage period is doubled, except in the case of 5 degrees when the period is increased to 30 days.

The Bureau warns that in many food locker plants, temperatures are not kept low enough to insure a complete kill in stored pork.

GERM-KILLING

By Ultra-Violet Light Has Great Possibilities

Rapid increase of air sterilization by ultra-violet light to include apartments, offices, private homes, military mess halls, barracks, and hospitals was predicted recently by Dr. Theodore S. Wilder. He pointed out that "curtains" of the invisible artificial sun rays have successfully lessened the occurrence of measles in selected Philadelphia schools, and infections following surgery in hospital operating rooms, reports *Science Service*.

Ultra-violet light, the part of the sun's rays which causes sunburn, is fatal to bacteria and apparently to the viruses, germs so small they cannot be seen under a microscope.

In apartments with air conditioning the ultra-violet light would be especially valuable, Dr. Wilder said, since "recirculated air has been proved to be a carrier of contagion. It may not be far fetched to hear a Mr. A complain that his invaluable secretary is laid up with grippe which he is sure she caught from his friend Mr. B 10 floors above him."

Private homes might provide ultra-violet sterilization for the nursery, particularly where the infant has just come from a sterile hospital nursery. Further, ultra-violet light might take the place of the sheet, soaked in antiseptic, which used to be hung across the door of the sick room.

Military hospitals, dispensaries, barracks, lavatories, mess halls, and recreation rooms might find ultra-violet protection especially valuable during winter and early spring in cold climates. Dr. Wilder warned, however, that "the mere presence of an ultra-violet source in a given room is no guarantee that it is accomplishing anything. Varying air currents and reflecting surfaces greatly alter the efficiency of the light," and he added that the need of a particular situation for ultra-violet light should be determined by physicians, and its installation made by experts.

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CLEAN?

Simple Test for Metal Parts

For blemish-free metal finishing—enameling, plating, galvanizing, tinning, and so on—it is imperative that the product be chemically clean—free of *all* foreign material.

Although these parts may look clean as they come from the cleaning room, it is entirely possible that traces of sand, scale, or other extraneous material may still be adhering. When that happens rejects in the finishing room become a certainty, with a consequent waste and loss of production.

Cleanliness test via open door

The simplest of all tests on iron castings, forgings, sheet steel (except stainless), and so on, is to make a saturated solution of copper sulfate (blue vitriol) to which a slight amount of sulfuric acid (2 percent) has been added. The use of this solution serves to detect the presence of iron in any form, including its alloys, by forming a bright yellow copper coating on the surface of the article tested.

Where sand, iron oxide, or foreign material is present, the surface will remain in its original color or may be blackened.

The material suspected of being chemically unclean can be tested either by immersion in the solution or by rubbing the solution on the work with a swab, such as the type used for throat painting. Special emphasis should be given to the fillets and cavities in the piece, if enameling or plating is to follow. It is a good idea to renew the solution or redip swab for each test.

For abrasive blast cleaning, it is a simple matter to determine when all pieces of a load in a Wheelabrator Tumblast are evenly cleaned, because all the operator has to do is stop the abrasive blast, open the machine door and conduct the test on a few selected pieces. Should additional cleaning then be necessary, the door can be quickly closed and the blasting resumed for as long as is required to remove whatever objectionable material may be present.

SAND BLASTING

Equipment For Design Cutting, Paint Removal

A light-weight sand blasting gun, equipped with a gravity-fed reservoir with a capacity of 1/2 pint, is now available for cutting designs in plastics, stone, glass, and so on. The same unit is also suitable for cleaning paint from small areas and for sand blasting small castings.

One of our photographs shows the complete sand blasting outfit including a portable compressor with a driving motor; the gun itself can also be operated on any compressed air source.

Abrasive from the reservoir is fed to a hardened-steel nozzle and is de-

Complete, ready for use

livered in the air stream when the trigger is pulled. The gun and its portable air supply source is manufactured by Paasche Airbrush Company.

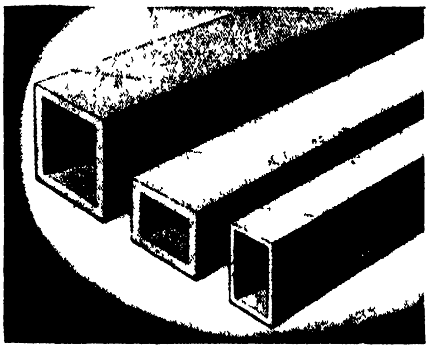
PAPER TUBES

Manufactured With Precision Tolerances

Paper tubes for electric coils, produced by the use of a specially adapted heat die machine, are now being made to precision specifications.

Heavy compression insures strength and resistance to collapse, accuracy in sizing, superior dielectric properties, lower moisture absorption rate, square corners, and straight side walls.

The improved tubes, produced by Precision Paper Tube Company, are preliminarily formed of dielectric kraft or fish paper, or a combination of both.



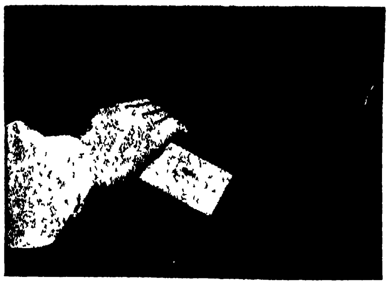
Also in rounds and ovals

The paper is spirally wound on a steel die in an automatic machine. The tube is then pushed pneumatically through the new heated compression die which effects an added compression of about 10 percent. Tubes made by this process can be obtained in round, oval, square, or rectangular cross section and in continuous lengths of any wall thickness with any inside or outside diameter. Tolerances are held to 0.002 of an inch.

COMMUTATORS

Kept Clean With Non-Clogging Stone

Excess film and dirt caused by heavy, continuous power loads on motors can be easily and quickly removed from commutators with a new cleaning stone announced by the Ideal Commutator Dresser Company. The stone cleans while the motor or generator is running. It is used by simply holding it against the commutator and slowly moving it across the face. The stone does not clog, nor cut the commutator. It also cleans film from the brush seats and helps to re-seat brushes.



Clean commutators serve best

So called "excess color," "skin" or "film" resulting from oxidation around paper mills, chemical plants, printing departments, Diesel locomotive generators, and so on, are all removed—only the "electric film" remains on the commutator assuring perfect commutation. Regular cleaning of commutators will help in keeping motors and generators on the job 24 hours a day. Only a clean commutator can be expected to function properly, with reduced noise, uniform brush wear and minimum chattering and sparking.

NO SLIPPING

When Floors Are Covered With New Powder

To provide traction on floors near machines, work benches, and other areas that tend to become slippery, a material in powder form has recently been put on the market by Theo. B. Robertson Products Company. The powder not only prevents slipping but absorbs oil and grease and is swept up and replaced when it becomes dirty and saturated.

OIL REMOVAL

From Metal Surfaces With Special Liquid

An industrial cleaning material for use in washing machines quickly removes heavy coatings of mineral oil from metal surfaces and leaves a rust-preventing film. This liquid, manufactured by Quaker Chemical Products, is used in the proportion of one gallon with 25 to 75 gallons of water and the resulting solution is maintained at a temperature of 130 to 175 degrees, Fahrenheit. It is claimed that the solution will not attack metals and that there is no danger of fire or explosion through its use.

The oil that is removed by the action of the solution floats to the top and can be skimmed off. Thus the only solution which is lost and requires replacement is that which is removed from the machine on the washed metal parts.

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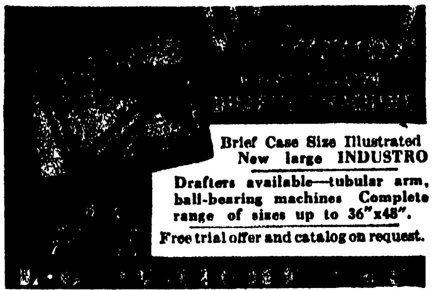

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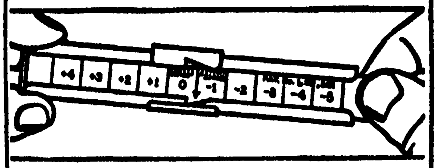

The DECIMALIZER shows in a few simple manipulations just where to place the decimal point in the result of any computation involving several elements, part or all of which may be decimals—for example, in such a problem as (9 x 0432 x 74 1 x 3 8) + (245 x 0098 x 36). The DECIMALIZER removes that "decimal point hazard" inherent in computations made with the slide rule or otherwise.

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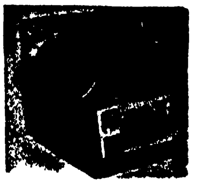

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Post-War Possibilities

Extensive Growth Forecast in Employment, in Both Manufacturing and Service Branches of Aviation

ALEXANDER KLEMIN
Aviation Editor, Scientific American
Research Professor Daniel Guggenheim School of Aeronautics, New York University

STUDENTS at several universities have written us for information on post-war aviation, a subject which seems to be providing the colleges with possibilities for theses. We have been loath to venture into the realms of prophecy A *Fortune* Magazine Round Table has been much bolder. If E. R Breech, Board Chairman of North American Aviation; E. P Warner, of the Civil Aeronautics Board, and Frederick C. Crawford, President of Thompson Products—certainly authorities on the subject—are to be believed, the outlook for post-war aviation is an excellent one.

Even if we achieve a complete victory over the Axis, there would be needed 24,000 military planes to police the world—since this time we would not allow our present enemies to get into further deadly mischief. The maintenance and ultimate replacement of these planes would, in itself, provide employment for 100,000 workers. Mr. Breech thought that the volume of private planes might reach 10 to 15 percent of the automobile industry's volume in five to ten years, but could not take up the slack in employment for the four or five hundred thousand men now employed in aviation Mr Crawford was much more optimistic. "People have not yet become accustomed to this convenience We have not seen anything yet. I think air transportation of perishable goods is coming. People have no conception of the land crews that will be necessary. We will have more people servicing and repairing and building and flying planes and selling tickets . . . "

Mr. Warner was still more encouraging, though he quite rightly pointed out that it was not price (that is, low price) which would make aviation generally acceptable, but the more complete solution of the problems of aviation. We must solve weather limitations, provide innumerable airports The unparalleled efficiency of the airplane was stressed by the eminent speaker. "So far as I know," said the Vice-Chairman of the Civil Aeronautics Board, "no vehicle on land or sea in surface transportation has ever yet operated on a basis of normal service per vehicle of more than 80,000 miles a year. However with the airplane 500,000 miles a year is common."

Another interesting thought was that the instruments or devices invented during the war for locating enemy aircraft might be utilized for commercial aircraft and enable them to keep out of one another's way in the foggiest weather.

Predicting an enormous growth in the carrying of passengers by air, Mr. Warner said that the annual operating cost for lines operating within the United States might be between six hundred and eight hundred millions a year.

AIRPORT CAPACITY

Imposes New Problems on Air Transportation

AIR traffic has reached such proportions as to raise the question of traffic saturation at major airports. During the last Labor Day week-end, La Guardia Field, New York City, handled 1364 airplanes between Thursday midnight and Monday midnight. With the normal distribution of air traffic that prevails at La Guardia this meant that one airplane was handled every two minutes—close to the utmost capacity of the airport. This was in good weather. Bad weather, even with instruments and blind-landing guides, inevitably cuts down the capacity of an airport. So already the capacity of La Guardia may be said to be approaching its limit. A. F Bonnalie, of United Air Lines, discussed the problem in very thorough fashion at the recent Airport Conference held under the auspices of the Illinois Institute of Technology. How is this situation going to be met, particularly when the present emergency ceases and more equipment is released to our air-transport companies?

Two definite schools of thought exist in regard to future provisions for metropolitan carrier terminals. One school, so Mr. Bonnalie tells us, adheres to the principle of a multiplication of fields at major traffic centers as the only solution of the problem. This is the simplest solution available, but it is subject to the same difficulties as are multiple station facilities for railroads, with their confusion for the traveler and the problems of transhipment from station to station. The second school of thought (to which we think Mr. Bonnalie himself belongs) believes that air carriers can best serve the public from one metropolitan air field.

To serve the public in this fashion, without prohibitive size of the landing area, much thought will have to be given to the spreading out of the traffic throughout the day, and to the design of the airport facilities. Duplicate runways will have to be made available for take-off and landing. Triple runways might have to be provided. The taxi-ways would be arranged for one-way traffic Hangar facilities and terminal buildings would have to provide sufficient frontage to handle a large volume of traffic quickly.

It is gratifying to see that the problem of airport capacity has already arisen. It will be solved by ingenuity and feeling for organization.—*A K*

DYNAMOMETER

Combination Unit Absorbs Full Engine Power

As aircraft engines increase in size, so do dynamometers, these are now being built by the score in sizes up to 4000 horsepower and some are being considered which will be even larger

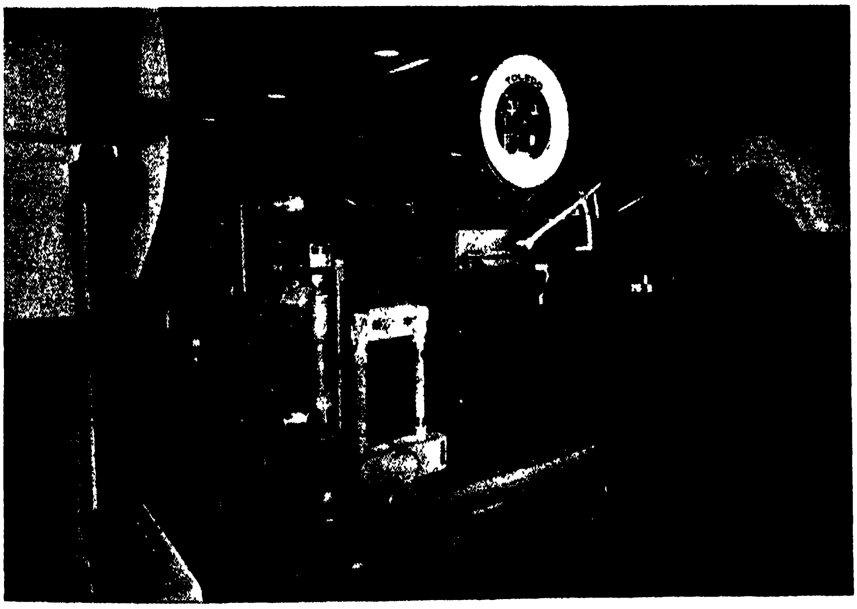
The Westinghouse dynamometers, installed by Detroit engine manufacturers, are representative of these testing installations In one of our photographs the airplane engine is out of the picture behind the wall at the left. From it there extends, through a flexible coupling, a shaft which drives an eddy-current generator capable of absorbing 2000 horsepower and a D.C. generator that can absorb 750 horsepower. The frames of both are cradled so their tendency to turn can be measured on a set of scales. The energy absorbed by the eddy-current generator is carried off as heat; that developed by the D.C. machine is returned to the power lines through a motor-generator set. This combination dynamometer can absorb the full power of the airplane engine at any speed up to 2000 rpm.—*A. K.*

PRONE FLYING

Has Advantages for Military Purposes

In a recent issue of "The Army and Navy Journal," it is stated that both the United States and Britain as well as Germany have for some time been experimenting with pursuit planes for prone flying The new Fokker Wulfe fighter plane, developed in Germany and still in the experimental stage, is designed so that the pilot and two-man crew all lie prone instead of sitting upright as in conventional ships.

Prone flying, first of all, tends to decrease the cross section of the fuselage and thus provides less drag and more speed But it has even more value in decreasing the "blackout" often suffered by combat pilots today In conventional planes, where the pilot sits upright, the centrifugal force developed when coming out of a dive is virtually perpendicular to the pilot's body and the blood drains readily from the pilot's head In prone flying, the centrifugal force is almost horizontal to the pilot's body This tends to reduce "blackouts", consequently the pilot can make tighter pullouts and spirals In dive bombing this permits delayed pullouts—*A K.*



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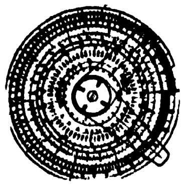

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Tone Separation

Dark tones against dark areas, light tones against light, bring a loss in the clarity of detail due to semi-absorption of the detail by the background. Unwittingly, however, some workers frequently find themselves faced with such a problem as that shown in the illustration, where the dark boat model is almost lost in the dark-toned shirt worn by the boy. An excellent picture, made, incidentally, by Robert Toran, of New York City, the print has good composition, good human interest, a fine expression on the boy's face. The lack of tone separation between the boat and the shirt is the only jarring note. A lighter shirt or side or back lighting for the boat would have done the trick and made a good picture better.

Tone separation could be better

Tabletop Trees

Ernest E. Draper, who is frequently referred to as America's tabletopper No. 1 because of the remarkable realism he succeeds in injecting into his pictures, invariably uses the small locust tree to simulate reality. With roads, mountains, houses, and so on, scaled to the tree, and employing a low viewpoint for the camera, the tree looks as real as life, as indeed it is, lending authenticity to the entire scene. Mr. Draper finds the tiny trees in empty lots and other abandoned places, and thinks it is ideally suited to tabletop use.

Kodachrome or Kodacolor

Now that we have them both, which shall we use? First, it is a matter of camera equipment. If you have a 35mm camera only, you are limited to Kodachrome, since Kodacolor is not available in that size. However, if you have a 35mm as well as a larger roll-film camera, and there is a choice, we would say offhand that the pictures you take on Kodacolor will be those you will want to give to friends or place in an album, while Kodachromes will be used for scenery, flower studies, and similar subjects. Another aspect to consider is the comparative speed of the two materials, Kodachrome being rated Weston 8 and Kodacolor Weston 20. The two mediums may, therefore, be used in somewhat the same manner as slower and faster black-and-white film is employed, suiting the medium to the requirements of the situation. Where Kodachrome is too slow, for example, for a required snapshot exposure, Kodacolor may do the job very well.

Filmo Moviquiz

The quiz craze has now been introduced by Bell & Howell in the 16mm rental film field in the form of the "Moviquiz." Explaining how the game works, the company says:

"The participant, student at school or guest at a party, is given a printed sheet of questions, and is asked to indicate the answers in the spaces provided. A film is then shown, in which the correct answers are found, and from then on, the grading of papers, rewriting of answers, or paying of 'forfeits,' is up to the teacher or host, as the case may be."

There is a choice of several series of new, one-reel films, for each of which a "Moviquiz Kit" is provided. This kit contains a set of question sheets, a master list of correct answers, and suggested methods of scoring.

How Do You Hold Your Camera?

Every worker has his own particular argument for the way he holds his camera, but the next fellow may present just as strong a brief for some utterly different method that happens to suit him. Both are

Convenience comes first

right because the method adopted by each worker is the best for him. It's just a matter of habit and convenience. The chap in the illustration finds the method shown especially helpful because of the way the Kalart synchronizer unit is attached. Turning the camera upside down gets the picture just the same and, for this photographer, with greater comfort.

Panda Bites Photographer

THEY call her Ylla, the famous European photographer of animals, and being rather pretty besides, she got ready permission to enter cages of animals at the Bronx Zoo in New York City, in order to make close-up shots with her twin-lens reflex. She was getting along fine when, one day, she entered the cage of the panda, ordinarily a harmless creature but on this occasion very effusive in her greeting of the lady photographer. Ylla insists even now that the panda was only playing and that the bites and scratches inflicted by the animal were mere tokens of affection. And, to top it all, Ylla is coming back again, explaining that the next time she is going to wear slacks as it appears the panda had taken a fancy to her legs which, the photographer having worn a skirt, were free.

Background of Cobbles

BACKGROUNDS in outdoor photography are frequently a bane to the amateur worker who has been cautioned against setting his subject in front of a cluttered-up scene, with the distracting effect that inevitably results. The usual method, where possible, is to shoot the subject against a sky background by having the camera low or setting the subject on an elevation. Another recommended procedure is to use water as a background; a third, a plain wall. A novel approach to the problem, recently reproduced in a fashion photograph in one of the leading women's magazines, was a figure set against a background of cobblestones. The shot was naturally made from above with the camera tilted down in order to get an over-all pattern of cobbles.

The Smoker

SMOKING a pipe, even when working in the darkroom, is something Robert Bagby likes to do. But ashes have a way of falling out of the bowl when the pipe is tilted a bit. Bagby never has any trouble with this difficulty, however, as he habitually smokes a pipe of the so-called outdoor type, with a hinged perforated hood. Designed for the hunter and sportsman who likes to smoke a pipe outdoors without the disadvantage of having ashes blow into his face, it seems to work as well for the outdoor photographer and indoor darkroom worker.

"Big Brother"

"Big Brother"

IN the contemporary annals of pictorialism, the name of David Darvas, of Cleveland, Ohio, is coming steadily into a place of leadership. One contributory cause is the reproduced print, "Big Brother," hung in the recent New York salon of the Pictorial Photographers of America. Mr. Darvas, who is a superb technician as well as a fine camera artist, manages in this print to satisfy both documentarian and pictorialist. We do not know the circumstances surrounding the making of this picture, but Mr. Darvas certainly is to be complimented on his skill and understanding in getting the children to assume such a natural attitude and expression.

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That Darkroom Sink

HAVING trouble with a leaky wooden sink? Then try this stunt. Get some white lead and a supply of candlewick. Fill in the cracks with the white lead and then stuff the candlewick in liberally. Of course, the sink must be thoroughly dried before these repair operations can be satisfactorily begun.

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CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

The History of Combat Airplanes, by Charles G. Grey, is a 158-page unillustrated brochure which deals with the evolution of fighting planes from pre-World War I days to the middle of 1941. The text is non-technical, giving an over-all picture of military aircraft. *Norwich University, Northfield, Vermont.—$1.00.*

Resistance Thermometers is a 30-page pamphlet which gives a comprehensive presentation of the nature, design, performance, and application of a broad range of resistance thermometers in industrial processes, scientific work, refrigeration, air conditioning, and so on. The types of thermometers are illustrated and fully described. Request catalog No. 9004. *The Brown Instrument Company, Wayne & Roberts Avenues, Philadelphia, Pennsylvania.—Gratis.*

The Jones Heavy Duty Hand Tachometer is a four-page leaflet describing an indicating instrument for measuring speed directly in revolutions per minute or feet per minute. *James G. Biddle Company, 1211 Arch Street, Philadelphia, Pennsylvania.—Gratis.*

Refrigerated Welding is a four-page folder which describes the "Frostrode" welding process and the advantages which it offers to industrial welding. *Weltronic Corporation, Frostrode Division, E. Outer Drive, Detroit, Michigan.—Gratis.*

Definitions of Electrical Terms is a 300-page bound volume, thoroughly indexed, presenting for the first time, under one cover, the definitions of the important terms common to all branches of the art as well as those specifically related to each of the various branches. *American Institute of Electrical Engineers, 33 West Thirty-Ninth Street, New York, New York—$1.00 in the U.S.A., $1.25 outside of the U.S.A.*

A Primer on Grinding Wheel Safety is a 24-page illustrated booklet which presents important facts for grinding-wheel operators in brief text and interesting cartoons. *Norton Company, Worcester, Massachusetts.—Gratis.*

20 Model Railroad Projects, by Frank Taylor, is a 120-page illustrated book which gives full and complete details on the construction of various types of model railroad cars, stations, signals, and other accessories for the model railroad hobbyist. Detailed drawings supplement the text. *Kalmbach Publishing Company, Milwaukee, Wisconsin.—$1.00.*

Squeegee Type Pump is a folded circular describing an industrial pump operating on an entirely new principle. It consists of a flexible rubber tube which is alternately squeezed and released in a rocking-squeegee manner so that the liquid or gas is "breathed" into or out of the tube. The pumps are available in capacities ranging from one-half to 50 gallons per minute. *Downington Manufacturing Company, Huber Pump Division, Downingtown, Pennsylvania.—Gratis.*

How Are Balls Made Round? is an eight-page folder which describes in photographs and text the essential processes in the manufacture of highly accurate ball bearings from the original pressing to the gaging of the finished product. *SKF Industries, Front Street and Erie Avenue, Philadelphia, Pennsylvania.—Gratis.*

The Automobile Users' Guide With War-Time Suggestions is a 66-page manual designed to help the public get the most out of its automobiles and to make them last longer by describing how to save gasoline, tires, and repair bills; also how to prolong the life of a car and keep it looking new. *Customers Research Staff, General Motors, Inc., Detroit, Michigan.—Gratis.*

Thermocouple Data Book and Catalog is a 32-page manual for thermocouple users. It lists various types of commercially available thermocouples and accessories and gives valuable information on their design and use. Bulletin No. S2-3. *Wheelco Instruments Company, Harrison and Peoria Streets, Chicago, Illinois.—Gratis.*

How to Run a Lathe is the 41st edition—128 pages, over 365 illustrations—of this popular book, complete with a number of changes which bring it completely up to date. It covers lathe operation, grinding tools, making measurements, boring, drilling, and so on, plus reference tables. *South Bend Lathe Works, South Bend, Indiana.—25 cents.*

Carboloy Tool Manual is a 32-page thoroughly illustrated bulletin covering such aspects as tool design, application, grinding, brazing, and tool handling. *Carboloy Company, Inc., East 8 Mile Road, Near Van Dyke, Detroit, Michigan.*—Gratis to industrial readers, libraries, technical schools, and colleges. Request this bulletin on your letterhead.

Magic Bottles is a 20-page illustrated booklet describing specifically the uses of compressed gases in aviation for such purposes as fire fighting, oxygen supplies for high altitude flight, and life-saving rafts and vests. *Aviation Division, Walter Kidde & Company, Inc., 140 Cedar Street, New York, New York.—Gratis.*

Fluorescent Accessories is a folder describing a complete line of fluorescent lamp starters, lamp holders, starter sockets, and other devices for use with these increasingly popular light sources. *General Electric Company, Appliance and Merchandise Department, Bridgeport, Connecticut.—Gratis.*

Cascamite Water Projects, by William F. Crosby, is a folded sheet describing plans which are available for the construction of small boats, water skis, aquaplanes, a sailing skiff, and an ice boat. *Casein Company of America, 350 Madison Avenue, New York, New York.—Gratis.*

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Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

THAT the equatorial type of mounting for telescopes is superior to the simple alt-azimuth mounting is something which many of us take more or less for granted. The alt-azimuth has two axes, one vertical, the other horizontal, and, in order to make it follow a star across the heavens, the observer must keep moving it in two directions—the "up," or else the "down," direction (altitude), and the "across" direction (azimuth). For ordinary small telescopes this manipulation is not so bad as it sounds, since the two little movements are made quickly and in a sort of stairway pattern Many who have used both types of mountings defend the alt-azimuth with vigor against all who pick on it. They don't claim that it is better than the equatorial, or even quite so good, but they do assert that, in some ways, it is almost as good, and that in any case it is not to be looked at down the nose

However, when the telescope is to be driven mechanically, and especially when it is to be used for photography, an equatorial mounting, having one axis parallel with the Earth's axis and the other at right angles to it, is necessity, for here the alt-azimuth is, or thus far has been, out of the running, since it will not make the necessary double corrections automatically This is one reason why all our great telescopes are equatorially mounted.

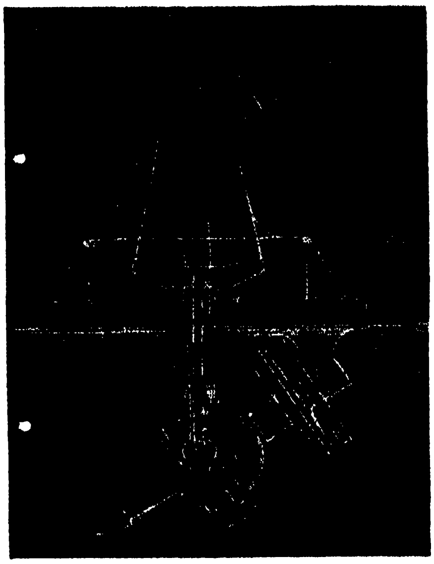

Figure 1: Original sketch, 1936

This situation struck A B Hendricks, Jr., 115 Wendell Ave, Pittsfield, Mass, one of the earlier followers of the amateur telescope making hobby, as remediable Why not use a mechanical linkage that would combine the altitude and azimuth motions automatically into a single, smooth equivalent of the equatorial motion?

After some study he drew up the simple sketch shown in Figure 1 (taken from an old notebook and therefore not in ideally reproducible form). In the upper part of this sketch is a telescope tube mounted on a vertical axis which rotates in azimuth. This vertical axis is driven through a linkage from another axis set diagonally (parallel with that of the Earth) and therefore an equatorial axis. Hendricks, when he sketched this proposal in 1936, called it a "transformer, equatorial to alt-azimuth." The diagonal element is driven at a uniform rate The object sought is essentially to drive the altitude and azimuth at the desired *non-uniform* rates In 1936 this sketch (Figure 1) was offered, through R. W Porter, for the 200" mounting, but it proved that this type of mounting had already been considered by those who were designing the telescope, but not employed because of the difficulties involved in overcoming the rotation of the image on plate, inherent in it.

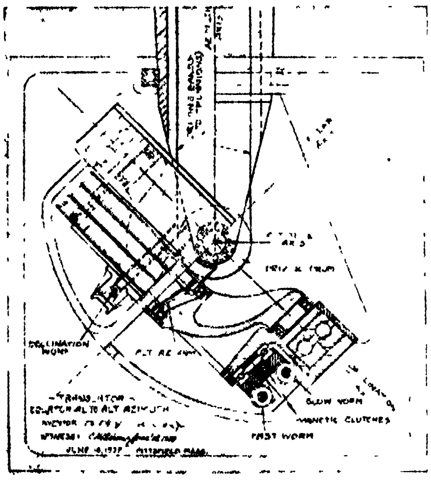

Figure 2: Subsequent version

Figure 4: Polar axis and bearing, setting and az circles, rear of tube

A year later Hendricks evolved the proposal shown in Figure 2 (another notebook sketch). This again shows a miniature equatorial placed below the alt-azimuth. In Hendricks' language, "the arched declination axis carries, pivoted within it, a spindle rigidly connected in a radial direction to the driving drum, which in turn is pivoted horizontally in the lower end of the azimuth axis on ball bearings The horizontal component of the motion of the declination axis is transmitted directly to the driving drum, and through the axis of this drum (altitude axis) to the hollow vertical spindle (azimuth axis). The vertical component is also transmitted directly to the driving drum and thence through the steel driving bands to the telescope trunnions, through a cross-shaft within the pedestals, and two additional sets of drums and bands Some parts are shown in half section "

In 1936, Hendricks had discussed the problem with H F Morse, Sasco Hill, Southport, Connecticut, and Morse set off

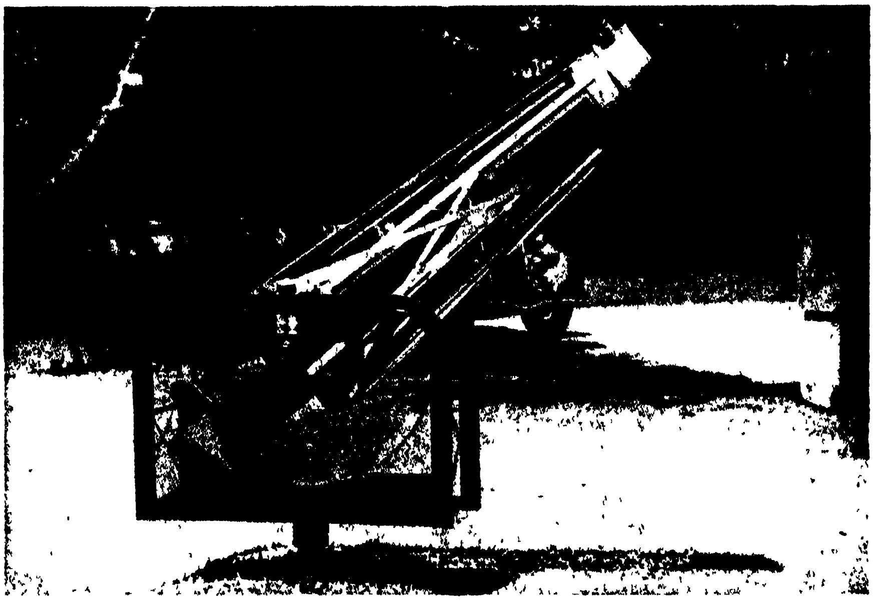

Figure 3: The altogether unique Morse alt-azimuth mounting

to accomplish the equatorial-to-alt-azimuth transformation in an entirely different manner (Figures 3, 4). He made the telescope mounting shown, and has exhibited this telescope several times at the conventions of amateurs held at Stellafane, near Springfield, Vermont, where it is always surrounded by a knot of by-standers

To many, on first seeing it, the working principle is a puzzle The principal unique feature of the Morse mounting is the curved, scimitar-like member seen in the photographs. This is the link, in the Morse version of the concept, which automatically brings about the desired transformation of uniform motion into non-uniform motion

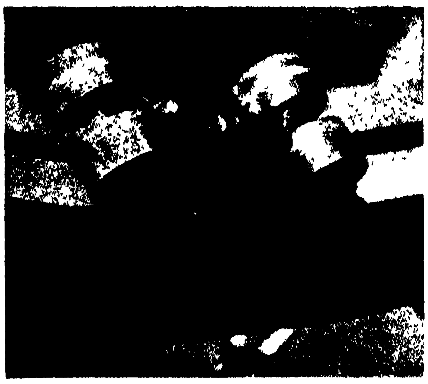

Figure 5: Close-up of carriage

But let's begin at the beginning. The following is a composite of Morse's description and your scribe's efforts—errors, if any, being chargeable to the latter.

At the very bottom (Figure 3), almost hidden in the grass and the shadow, is a bird's-foot base, holding in its center a short, stubby, vertical shaft.

Supported on this shaft by Norma-Hoffman ball bearings is a large rectangular frame of fabricated metal, which can be rotated about this vertical axis

Near its top part this frame supports the horizontal axis bearings. The hollow end of one of the horizontal axis trunnions shows clearly in the photograph.

Supported on the upper end of the stubby vertical shaft of the base mentioned above, in addition to the rectangular metal frame just described, is a trough-shaped platform (see also Figure 4) which is tightly clamped to the shaft. At one end of this platform rises a diagonal bracket. This bracket contains the bearing for another stubby shaft, the polar axis shaft.

On this stubby polar axis shaft is mounted the long, curved member—the alt-azimuth circle. This curved member, which is supported only at one end, can be rotated about the polar axis just described; that is, in Figure 3, swinging toward and away from the eye (like a sickle turning in the hand when the wrist is rotated but not otherwise moved). Its radius of curvature in any such rotational position remains in the common point through which the three axes—optical, horizontal, and polar—pass.

Slidably mounted on the curved inner surface of the alt-azimuth circle is a small carriage (Figure 5). Between the two sets of wheels of this carriage is a disk with a central hole (actually, this disk is a small ball-bearing). This disk is mounted in such a way that its bore always points toward the point through which the telescope's

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axes pass. The telescope tube, mounted on the horizontal axis, carries, at a central point in its bottom, a short pin, and wherever the tube is pointed this pin remains inserted in the central hole of the bearing.

In Figure 3 the tube is so positioned that its optical axis coincides with the polar axis and *in this one special position alone* the curved member can be swung without moving the tube. However, when the carriage is moved along the curved member (Figure 4), and the curved member is then moved (by rotating the short polar axis at its end), the optical axis is caused to rotate around the fixed polar axis and the telescope is automatically constrained to follow the star toward which it is directed.

Another way to explain this unique drive would be the following: Follow a star for a time by means of an ordinary alt-azimuth mounted telescope. Then the trace of a given point at the rear of the mirror would take the form of a curve like the curved member of the Morse telescope

When handling the tube of this telescope one has the feeling that an invisible spook also has hold of it, since it resists attempts to move it in any direction other than one which would follow a star. For example, if one tries to move it only in azimuth, it insists on moving at the same time in altitude. The "spook" is the curved guiding member.

What advantages does Morse claim for this mounting?

"The object," he states, "was to avoid certain inherent shortcomings in large equatorial mountings.

"Estimates indicate a much lower cost. Materials could be better used—with lessened total weight.

"Because there would be no transfer of weight from one bearing to another, there would be no distortion of parts.

"Because of ease and flexibility of the adjustments, less precision work would be required on various details.

"Astronomers would work in an always level position and in a constant temperature room at either end of the horizontal axis, where light could be directed with three reflections.

"Because the tube moves about the horizontal axis in one plane alone, the tube could be made very rigid and at the same time relatively light. The whole instrument could be floated in an annular tank of mercury, thus leaving only enough weight on the annular track (precision ground) to insure accurate rotation around the vertical axis."

AMATEURS who aspire to build 200" telescopes usually start more modestly, say with a 100" telescope, and work up by 100" stages. Erl A. Dart, 2466 S. Bannock Street, Denver, says he had never before built a complete telescope, so he simply started right out on the 200" telescope shown in Figure 6. The job consumed 60 hours of time, $4 worth of brass and two watch crystals (for the mirrors): it's a model, 3/32"=1 foot.

IF you don't want to buy, or in present times can't buy, a synchronous motor for a telescope drive, there is a way to make one yourself, and C. J. Myers, 417 N. Virgil Ave., Los Angeles, Calif., explains it thus:

"It may be that most amateurs are not aware that almost any AC motor can be converted into a synchronous one. A washing machine motor, fan motor or, for that matter, any squirrel cage motor will do.

"All that is necessary is to determine the number of poles and cut an equal number of flat spots on the rotor. For example: a 4-pole motor would have a rotor divided into 8 equal spaces. Cut every second or alternate area down about 3/16". The easiest way to do this is to set the rotor off center in a 4-jaw chuck—although a milling machine will do a better job, as the rotor should be balanced afterward. The motor will now have about one-third its original H.P. at synchronous speed.

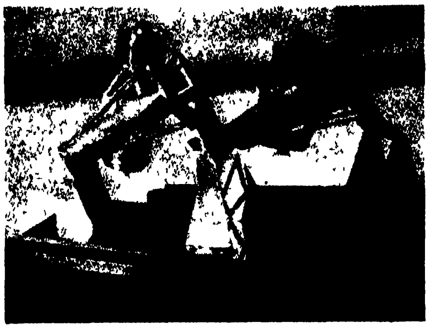

Figure 6: The 200" and its ghost

"The number of poles equals the frequency × 2 × 60 divided by the nearest synchronous speed up (based upon the number of cycles).

"Most small motors are 4-pole. If the rotating element is cut, it should be balanced. The usual method is to have two parallel knife-edges (any sharp straight metal) on which the motor is rested on its bearings. Small holes are drilled in the heavy side until it will come to rest in any position.

"The governor fly balls on all generators at Boulder Dam are driven with this type of motor. The speed drift is about the lowest in any power house built today."

Asked to supply a little background data on motors, Myers writes: "This motor speed business seems to confuse a lot of people. All motors having salient poles (with teeth) run synchronous. All motors with round rotors (without teeth—smooth) will have a definite slip below synchronism in proportion to load. This is where my formula comes in. Usually the name plate on this class of motor indicates the speed at full load. For example: the synchronous speed for a 4-pole motor, on 60 cycles, is 1800 rpm, but the average motor runs 1760 rpm. The same motor on 50 cycles synchronous is 1500 and the motor runs 1440. The formula for a synchronous motor is frequency × 2 × 60 divided by number of poles. In other words, any motor that is converted will speed up about 5 percent. Any good winding shop could change the number of poles within limits depending on the size of the motor."

NO convention of amateur astronomers will be held at Stellafane, Springfield, Vermont, this summer. Reason: War. Few could attend because most amateurs are doing war work (also saving tires). Springfield itself is too busy (working seven-day weeks) and too overcrowded to entertain.

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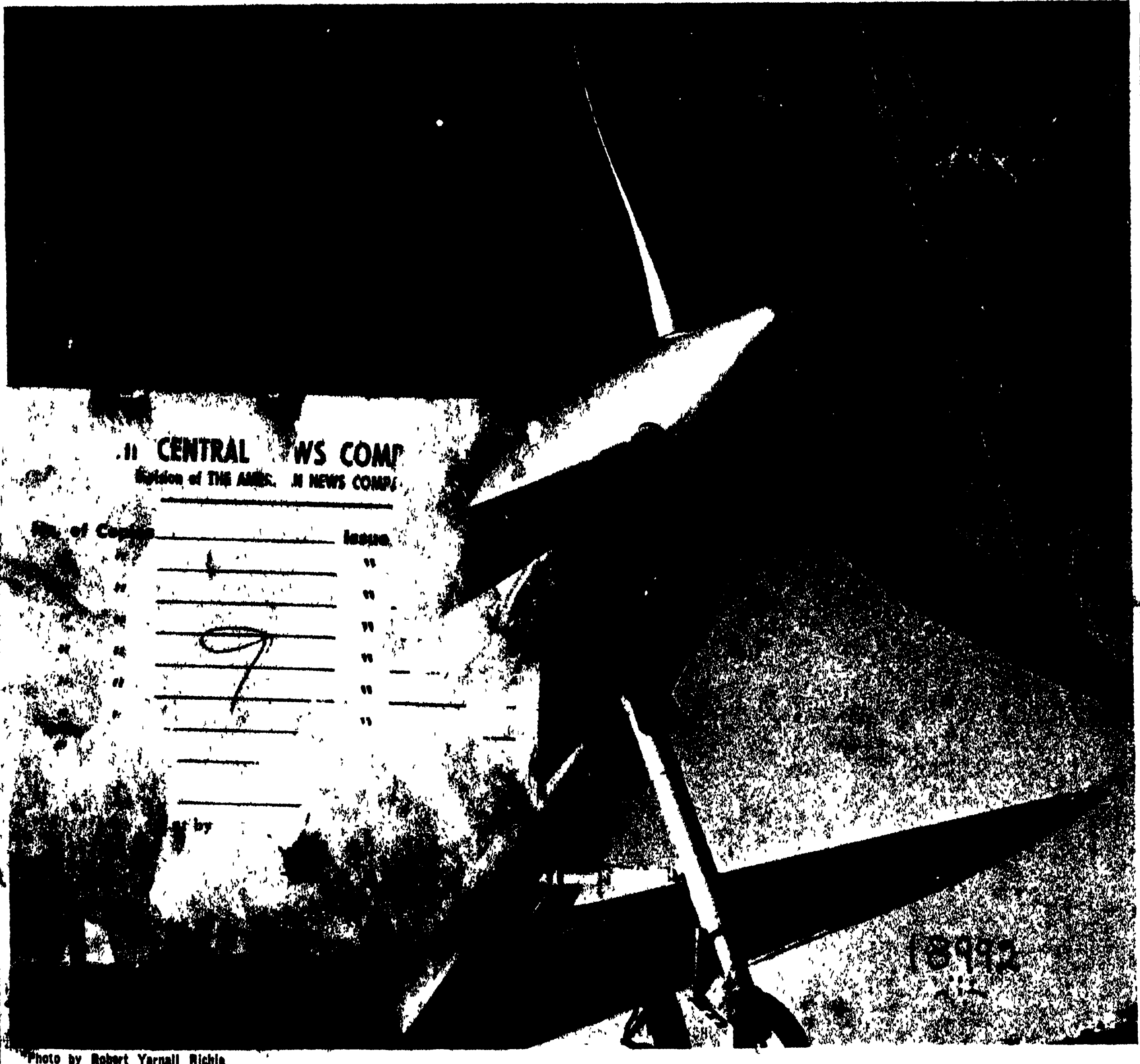

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Aerial Horsepower

Research workers on war problems may find the answer in the following list

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Metals:

Aluminum castings corrosion protection
Foundry cores
Joint seals for pipes
Aluminum drawing lubricant
Tin stamping lubricant
Nickel alloy stamping rust prevention
Metal surface protection
Drawing and stamping of nickel alloys
Sintered bearing lubricant

Paper:

Transparent coating
Waterproofing liquid
Flameproofing agent
Translucent paper
Wax coating

Textiles:

Transparent coating
Olive oil substitute
Waterproofing liquid
Textile lubricant
Flameproofing agent
Flexibilizer for cotton braid
Dye solvent
Textile emulsions
"Nylon" and "Vinyon" lubricant
Worsted and spun rayon lubricant

Ceramics:

Binder for ceramic insulation
Protective coating against mechanical abuse
Binder for vitreous enamels
Binder for abrasive wheels
Binder for porcelain enamel frit

Pharmaceuticals and Foods:

Edible emulsifying agent
Non-staining ointments
Edible fixative oil for candies
Binder for yeast tablets
Enteric Coating
Polish for tablets and pills

Adhesives:

"Cellophane" and cellulose acetate adhesive
Tissue paper to aluminum adhesive
Adhesive for rubber to cloth
Thermosetting cement

Paints, Varnishes, Colors and Pigments:

Pulp color and pigment dispersing agent
Flatting agent for paints and varnishes
Emulsion paints
Lacquer and varnish plasticizer
Soft grinding of lake colors
Increased length of pigment lakes
Non-mar enamels
Water and ink resistant lacquers

Rubber and Synthetic Rubber:

Gasoline resistant finish
Rubber gasket lubricant
Rubber to cloth adhesion
Polishing of hard rubber
Plasticizing synthetic rubber

Cork:

Cork preservative

Cements:

Waterproofing agent

Wood:

Warpage prevention
Flameproofing

Leather:

Sulphonated oil substitute

Plastics:

Plasticizer and lubricant
Polishing
Lubricant for molding

Miscellaneous:

Wax which will not melt in boiling water.

Substitute for Montan Wax, Ozokerite, Japan Wax and other imported waxes.

Dry preservation of anatomical and pathological specimens by the use of a water miscible wax.

Synthetic oils dispersible in water that do not contain soap, or added emulsifiers.

Emulsifying agent for emulsions stable to strong acids, salts and other electrolytes.

Photographic offset plates are improved, giving increased water solubility, spread and wearability by the use of a new type of binder.

Defoaming agent for casein, gelatine, shellac and similar products.

Wax which "dissolves" in hot water.

Oil which remains fluid at —50° C. without freezing.

Abrasive wheels. A temporary binder for abrasive wheels which completely volatilizes on firing.

A wax which combined with oil soluble dyes serves as a light filter and watch glass holder in the dissection of small organs and organisms.

A number of glycerin substitutes meeting specific requirements are now being marketed commercially.

Lanolin for industrial purposes can be replaced by a new compound made from domestic raw materials.

In laundering white garments, if the filler is washed out, the original stiffness and body can be restored by a new water soluble, colorless synthetic resin.

A liquid foam producer to replace Saponin for industrial purposes, is now being offered.

A hygroscopic, water soluble liquid which is an excellent dye solvent and which replaces glycerin in many instances.

Gum Tragacanth Ribbon is being replaced by a new edible gum of domestic origin.

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of July, 1892)

PATENTS—"Disparagement of patents is common and easy but it should not be forgotten by those who sneer at inventors that, out of a total of over $8,000,000,000 of capital invested in manufacturing in the United States, patents form the basis for the investment of about $6,000,000,000. Evidently, the United States system of encouraging invention that has resulted in the patenting of over 475,000 inventions, is a system that is exceedingly wise and valuable."

CENTRAL SCREWS—"A new ship has just cast anchor at the Louvre wharf—the steamer *Louvre*, built by Mr Oriolle of Nantes. When loaded it sinks but 2.8 meters in the water, and is consequently capable of ascending the Seine with a full cargo. This quality is not the only one that makes a truly original ship of the *Louvre*; it is the first ocean vessel provided with two central propellers . . . These two propellers are placed a little forward of the center of the vessel . . Each revolves in a sort of tunnel having the form of an inverted U . . . The propellers, which are 1.8 meters in diameter, and of 2 meters pitch, in revolving suck the water in front and force it aft As the tunnels are not closed at their lower part, the cavities that they form on each side of the center of the vessel increase the stability of it."

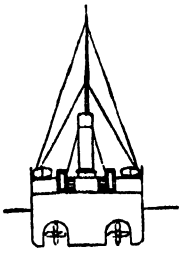
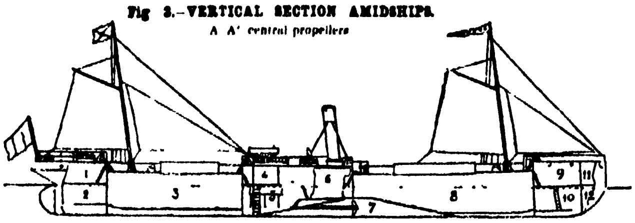


Fig 3.—VERTICAL SECTION AMIDSHIPS.
A A' central propellers



1 Stern cabins. 2. Provision room. 3. Aft merchandise hold 4. Engineer's room 5. Engine. 6. Boiler 7 Propeller tunnel. 8. Forward merchandise hold 9. Crew's quarters. 10 Wine hold. 11 Store room. 12 Galley

WRECKED—"The schooner Henry B. Tilton was recently wrecked off the United States Army Ordnance Proving Grounds, at Sandy Hook, by a 575 pound projectile which went astray after leaving the muzzle of a 10-in breech-loading rifled cannon The projectile struck the vessel on the starboard counter, crashed through her longitudinally as if she were an eggshell, and before the crew realized that the craft had been struck, the water poured in through a great splintered hole in her port bow, where the shot had emerged."

AIR LOCOMOTIVES—"A compressed air locomotive is reported to have been successfully used for several months in the interior of the Old Eagle Mines, near Pittsburgh. . . . Generally the construction is the same as a steam locomotive, with the omission of the boiler and water tank, these being replaced by two large cylindrical tanks holding the compressed air. . . . The locomotive carries air at 500 to 600 pounds pressure but ordinarily the pressure varies from 250 to 450 pounds. . . . If charged to 500 pounds, the engine can make a distance of 1 1/3 miles, doing heavy work, and it is practicable to make a running capacity of 4 miles with one charge"

SHIP BUILDING—"On account of the contracts undertaken by the Union Iron Works in the building up of our new Navy, the establishment now occupies a position of much general interest. Here in South San Francisco were built and equipped the highly successful cruisers *Charleston* and *San Francisco*, and here also was built the monitor *Monterey*, now receiving her finishing touches, and being supplied with what are believed to be some of the most perfect of high-powered guns yet made anywhere In addition to this work there is now on the ways one of the largest of the new battle ships, the *Oregon*, to have a displacement of 10,000 tons, and to cost, exclusive of armament, nearly four million dollars."

CABLE—"The United States survey steamer *Thetis* arrived at Honolulu on May 20 from Hilo, where she ended the survey for the cable to be put in between San Francisco and the Hawaiian Islands. The course to Hilo comprised 2,060 miles. . . . The soundings were made at intervals of two, ten and sometimes one mile apart. The deepest was 3,228 fathoms, about 245 miles northeast of Hilo, and the shoalest was 976 fathoms, at a point about 350 miles from Point Conception Were it not for this abrupt rise, the course would have been almost level."

TEMPLE ROCK—"For more than 2,000 years, a dressed stone containing 12,922 cubic feet—being 71 by 13 feet in size - has rested on pillars in a quarry of Baalbac, in Syria. It was intended for the foundations of the temple of the sun, a mile or more distant, to which four stones nearly as large were actually transported"

GUM CHEWING—"It is a curious fact that in England they do not chew gum but rather look down upon the habit as being vulgar, and of the small quantities that have been shipped abroad, but little has been sold. The time doubtless will come, however, when this democratic habit will overcome the prejudices of our cousins across the water . Already Australia has thrown up her hands, and decided that gum is a necessity, and American manufacturers are working that market for all it is worth"

CAMERAS—"While it may be too early to say the old-time plate-holder camera has had its day, it cannot be denied that magazine cameras of various kinds are superseding the old-fashioned camera, especially among tourists and others who desire to accomplish a great deal photographically in a very short time"

AURORA—"Experiments made at the Royal Danish Academy have demonstrated approximately the height of the aurora borealis M. Adam Paulsen, at Godthaab, by means of two theodolites situated four miles apart, found that different aurora displays varied from one to four miles in height. Experiments near Cape Farewell showed the height of different auroras to vary from one to ten miles. At Spitzenberg the range of height was from one-third to eighteen miles"

OUR *Point* OF VIEW

MASTER SCIENCE — IN WAR, IN PEACE

As most middle-aged and older readers will recall, the chemists were the fair-haired boys in World War I Today, in World War II, the fair-haired are the physicists—exalted to the level of a kind of war nobility. As the chemist, President Conant of Harvard, has said, it is a physicist's war. (In fact, the chemists are being treated shabbily. The secretary of the American Chemical Society, Dr. Charles L. Parsons, states that several hundred chemists and chemical engineers, including some with seven years of training and additional years of experience, have been inducted into the Army and are now functioning as stretcher bearers, orderlies, pharmacists' clerks—their costly training lost to the nation. These tragedies have been caused by local draft boards which probably don't fully comprehend that a chemist is a basic tool of industry Yet all efforts to remedy this situation have completely failed, in spite of the fact that the entire matter has been forcefully presented to high authority. This is a physicist's war but chemists still are highly vital to its conduct.)

Day and night, behind locked doors and under watertight oaths of secrecy, the majority of this nation's outstanding physicists are hard at work at what may prove to be the key to the war effort: Canny applications of the interactions of matter and energy—that is, of the science of physics—directed toward the single aim of cracking Hitler.

In the systematic search for the ablest physicist workers, the personnel of physics has been combed over again and again, and now the nation is to be fine-tooth-combed for physicists of lesser degree clear down to the rank of high-school graduates and even below that Officers and faculty members of high schools are being officially urged to single out youths who have shown innate aptitude for physics and its working tool, mathematics, and to direct their interests more actively into these channels with two ends in view: the help which these youths may later (but not much later) lend to the war effort, and their own peacetime futures in the one science which now seems most likely to be the great science of the future

Just why is World War II so greatly a war of physics, and in what exact ways are the physicists so close to the core of it? This can be told only approximately at present and, for the rest, the answer must be simply: Hush. Let the War Policy Committee of the American Institute of Physics, representative of the whole body of American physicists, state it: "The present and potential contributions of physics may well have a profound effect on the outcome of the war because new tools have been devised which can swing the tide of victory These tools utilize results of research in electronics, electric waves, acoustics, mechanics, and optics. Physicists have devised them, and engineers have shaped them for manufacture, and manufacturers are producing them." Top physicist of those who are participating in these defense—or rather, offense—research efforts is Dr. Vannevar Bush, Director of the Office of Scientific Research and Development (OSRD). He has commented on this question most succinctly: "OSRD members listen and do not talk."

As long ago as last October three fourths of the outstanding physicists were heading OSRD research projects for war offensive uses. Since December 7 that percentage has run steadily upward and the need for physicists now increases at the high rate of 1500 to 2000 per year.

In addition, there now is a special need for 100,000 or more individuals who, while not full physicists (eight years of training and experience), are well enough schooled in physics and mathematics to accept training in technical war operations. This is why the governing body of American physics urges a search among ordinary student bodies—college undergraduates and high school—for those who have innate aptitudes in these subjects. (Mathematics is the most important tool of physics.) Our readers may do a service in helping to sleuth out such youth and perhaps influence them, not only to help now, but, if they prove to have special abilities required in large enough measure, to become physicists for life.

Here one may well inquire about the moral responsibilities involved in influencing another's life. Will physicists not become worth but a dime a dozen after the War? Admittedly, some temporary helpers will, but those of them who prove to be born physicists never will. For the physicist—the first class or research physicist—has a mind and makeup which simply cannot be made to order. To begin with, it must be decidedly a first-class mind Then an analytical mind Objective Free from emotional bias Capable of dealing in abstractions. In addition to these there is a something, often remarked by scientists—a matter largely of attitudes and outlook. The born physicist is in part detached from reality—he lives in an ivory tower This explains why he is not well understood by practical people and why he stumbles across so many impractical findings that later turn out to be eminently practical. His mind is altogether free It soars, though under full control Sometimes the physicist's mind seems to conventional minds just slightly crazy—usually a matter of wrong emphasis! Crazy like a fox

A youth who exhibits some aptitude for physics but not enough to become a peacetime research physicist will not in any event have wasted his time As the Institute of Physics states: "The study of physics (irrespective of any post-war career) is immeasurably helpful in any walk of life, because such study improves the ability to understand the new physical environment which man is creating for himself, and which, far more even than now, is bound to exert a major influence upon social, political and economic trends. Great new developments now appearing behind the veil of secrecy are, beyond all possibility of doubt, establishing the basis for unprecedented peacetime applications of physics in industry Some of the greatest of these are along lines not yet developed as branches of engineering. They give promise of opening large and fruitful fields for the useful and profitable employment of those well equipped with a broad, fundamental training in physics." In Scientific American last May, Dr. E. U. Condon, Associate Director of the Westinghouse Research Laboratories, explored phases of the same general subject First-class research physicists can never become a dime a dozen: They are counted only by dozens.—*A.G.I.*

98TH YEAR SCIENTIFIC AMERICAN JULY 1942

HORSEPOWER IS WAR POWER

How American Industry is Powering Our Military Machine

CHARLES F. KETTERING
Vice President of General Motors Corporation, in charge of Research

Today's machine war is horsepower war. It is important for Americans to remember this, because we have available more horsepower per individual than any other nation on earth. We are the world's largest producers and consumers of horsepower. We produce enough power in peacetime to supply 15 horsepower to every man, woman, and child from Maine to California and from Canada to the Gulf. Automotive engines alone supply more than 65 percent of this horsepower in peace.

With the coming of war the power available per individual is stepped up to even greater quantities. For every soldier in a modern mechanized division there are 32 horsepower behind him, twice as much as in time of peace. We call this the machine age; we really are living in the horsepower age.

One of the most important things about horsepower is the fact that man by himself possesses so little of it. While the strongest athlete can exert as much as two and a half horsepower for perhaps a minute at a time, he is good for only about one tenth horsepower in sustained effort. The fact that this amount of power is barely sufficient to turn a 12-inch electric fan will give you some idea of what a small amount of power we can produce by our own muscular effort. Just to make your toast in the morning requires more power than five able-bodied men can generate by turning an electric dynamo. The American housewife, although she probably never thinks of it in this way, has in her home the equivalent of at least 60 servants in electrical appliances to do her bidding. If we add to these 60 servants the 75 or a 100 equivalent horses stabled in the family garage, we see that the typical small American home can boast a staff that would certainly have been the envy of any Medieval castle.

Naturally, these tireless, obedient, reliable servants did not spring into being by magic. There are years of trying and failing and trying and failing and of slow, patient accomplishment behind every one of the thousand little conveniences which we today accept as a matter of course. Our conveniences are the concrete result of industrial research in action.

Since before recorded history man has searched for means of augmenting his puny one tenth horsepower. The lever, the inclined plane, the screw, the pulley, and the wheel provided him with the means of extending the usefulness of his natural muscle power, but they did nothing to increase it. These five fundamental devices, upon which all machines are based, may be considered as extensions of man's facilities, just as the first stone he threw was in effect an extension of the striking power of his arm. In the same sense, the sling which David used with such effectiveness against Goliath, the long bows with which the English farmers routed the French armored knights at Agincourt, the crossbow, the catapult, and the battering ram were simply extensions of man's own muscle power.

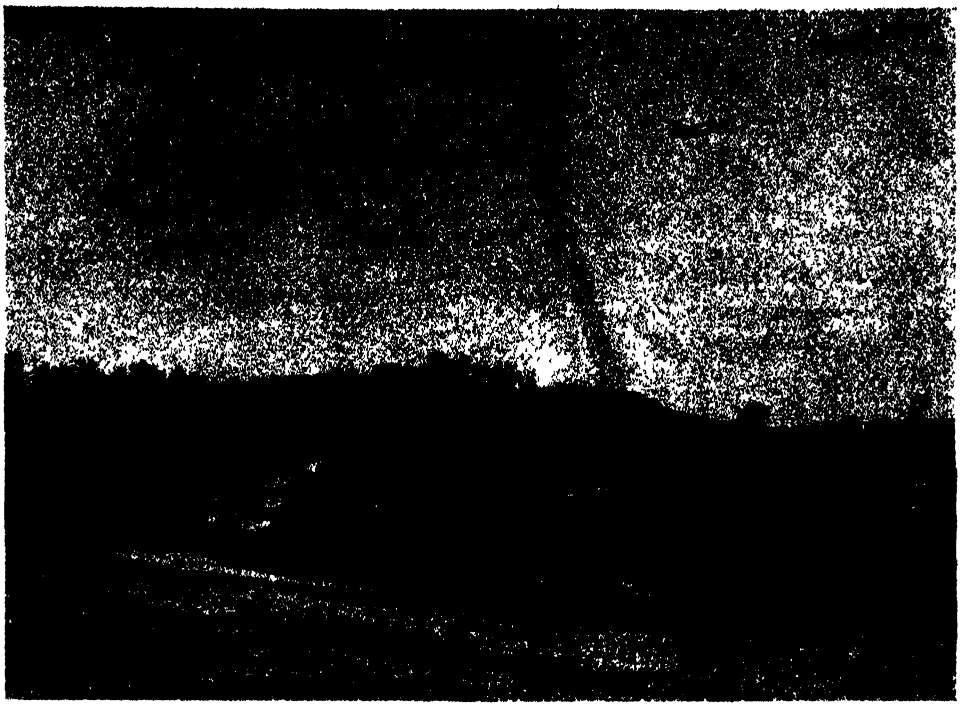
The first significant increase in the amount of power which man brought under his control came when he learned to domesticate animals. With the domestication of the horse, man increased his power tenfold, and he took the first step toward becoming a controller rather than an expender of power. There are few animals that have not at one time or another lent their muscle power to the tasks man proposed. Even the bird—usually thought of as the freest of all creatures—was conscripted to his purposes, carrier pigeons supplying the original airmail service. Hannibal was among the first to use this new source of animal power for war. The elephants with which he startled the Romans in 218 B.C. were simply the forerunners of the present-day tanks Later, Ghenghis Khan — still the champion conqueror of all time—swept westward through Asia and Europe with great armies mounted on Mongolian ponies. But even more important than his cavalry, Ghenghis brought with him a fantastic new toy, the Chinese firecracker.

Here was an altogether different source of power. There was nothing muscular about it. A small child could set off, as easily as a grown man, a charge of sufficient force to blow up a whole fort. It was entirely unlike anything that had existed before. Man had discovered how to harness the terrific energy of a chemical reaction. While he had increased his power tenfold by taming the horse, he was now able to increase his power a hundredfold or a thousandfold by taming the chemical animosity of saltpeter, sulfur, and charcoal.

There was another significant aspect to the discovery of gunpowder. Unlike the wind man had used to propel his boats or the water he had used for pumping or grinding grain, gunpowder provided him a form of power that was extremely compact and mobile, that he could use whenever, wherever, and however he wanted it as long as he kept it dry. This becomes especially significant when we understand that the internal combustion engine is simply a first cousin of the cannon. As a matter of historical fact, the first internal combustion engine was a gunpowder engine invented by Christian Huygens, a Dutch scientist, in 1680. There is no essential difference between a cannon and the cylinder of a modern gasoline engine. The piston is simply an adaptation of a shell with a connecting rod attached to it in such a way as to restrict its movement and provide a means of transmitting its power. And the reaction of gunpowder in the presence of heat is no different from the reaction of gasoline in the presence of the spark from a spark plug. You can say that the automobile you drive is run simply by six rapid-fire cannon arranged in such as way as to give you a smooth flow of power at the wheels.

The development of the gasoline engine followed naturally from the discovery of gunpowder. The horsepower which one man could control and direct to do his tasks had now grown to enormous proportions. Manpower, particularly in warfare, had become a relatively inconsequential matter. The French army was certainly numerically superior to the German, but the *panzer divisionen* was as radical an innovation in horsepower as Hannibal's elephants or Ghenghis Khan's ponies. German airpower was numerically superior to the British, but last fall's scheduled invasion of Britain failed because a few Spitfires and Hurricanes had enough well-utilized horsepower to hold off a greater number of Messerschmidts and Stukas.

The soldier of today is still a puny one tenth horsepower machine, but he now uses his one tenth horsepower to direct the greater horsepower which these new weapons have given him. He is like the tiny grid impulse which regulates the heavy plate current of a vacuum tube so that the sound of a pin drop can be amplified and magnified until it booms like a clap of thunder.


Tanks, trucks, planes—millions of horsepower

World War I was simply a great proving ground for two power-using weapons—the tank and the airplane. As with every new thing, no one foresaw the possibility that these two weapons would entirely change the existing methods of warfare. Land war had become a contest of endurance between large masses of troops in trenches. All movements were made slowly and in one plane of activity. Because the general acceptance of a new thing is always slow, no one realized that these two weapons, which augmented the feeble power of the foot soldier with that of the internal combustion engine, at once made it possible for him to move swiftly and in any direction he chose. The airplane took the lid off every fortress and island in the world.

Then one man who did not know anything about engineering completely changed our ideas of a fixed warfare and made us accept these new weapons for what they are. He started a program to build 20,000 tanks and 20,000 airplanes and even wrote a book telling people exactly what he was doing Everyone said he was crazy. When he finally got his 20,000 tanks with from 100 to 400 horsepower each and his 20,000 airplanes with 1000 horsepower each, he was able to substitute horsepower politics for ordinary diplomacy. So far, horsepower has won every battle. Now our job is simply to produce more horsepower than he can.

Time will show that the Axis picked the wrong opponent when they picked the United States to fight a horsepower war. We have the greatest power-producing facilities in the world. The automobile industry, for example, has produced over 80 million vehicles since 1900. If we say that each of these averages 50 horsepower, which is a very conservative rating, we see that we have produced four billion horsepower for use on our highways alone. In one average year we have produced over 200 million horsepower. We have about 40 million horsepower installed in electric power plants. These plants light our homes, streets, and factories; they provide power for our industries; they distribute electrical energy for our great communication systems. In a hundred ways they furnish the power to make our American way of life possible. Forty million horsepower is a lot of power, but it is less than one fifth of the amount of power the automobile industry turns out in an average year. In other words, it takes us less than three months to duplicate all the power production of all the electric power plants in the country.

When military men ask for huge totals of power to win the war, they are not speaking in unknown terms to the automobile industry. When we needed 200 million horsepower a year to keep our American way of life in peace, industry produced it. We have learned, better than any other country, the mass production of power. Every bit of this accumulated experience, together with all the resources of management, machinery, and labor, is being used to produce more and still more horsepower to win the war.

Let us examine the difference between a division in World War I and a modern mechanized division and see if we can gain some idea of the magnitude of the job industry is called upon to perform.

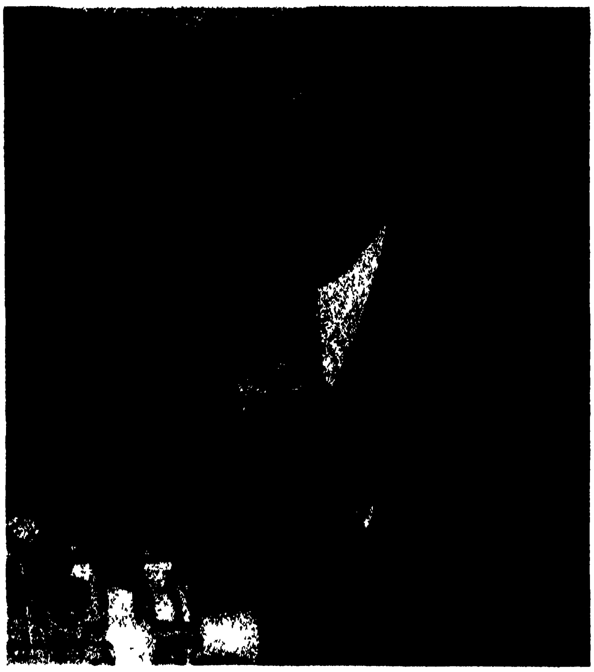
The old division used 4400 horses and 153 motor vehicles of about 3500 total mechanized horsepower. The modern mechanized division, with fewer men, has 2700 vehicles ranging in size from the motorcycle to the heavy tank. More than 400,000 horsepower are available. The old division moved at 3 or 4 miles per hour with 25 miles a long day's advance. The increase in power of the new division gives it a speed of from 25 to 60 miles per hour, and it can easily travel 250 miles in a day. The old division required 39 tons of ammunition per day. The new one 600 tons. No wonder the *panzer divisionen* struck such terror in the hearts of the French soldiers.

This 400,000 horsepower represents the effort that could be exerted by 4,000,000 men. And the mechanical equipment —tanks, trucks, jeeps, peeps, and motorcycles—are no more tired at the end of a long day's advance than they were in the morning. The mechanized division is made up of about 12,700 men and officers with an average of 32 horsepower available for each man. This power is used to increase the soldier's speed and mobility, carry more and heavier guns, and allow for heavier armor to protect him in battle. Each man has available an average of the combined power of 320 men In a tank, he may have the equivalent of 1000 men acting from his orders

Many of the vehicles necessary for a mechanized army are now being produced in large quantities and have been for the last year. Other and newer types will soon be in large scale production. For a long time the army has worked with industry to build the vehicles that will be necessary. As we have repeatedly pointed out, it takes time to get an entirely new product into production. Even with industry's great skill in methods of producing horsepower, it does take time to get through the "tooling up" stage. Now that industry is gearing itself to the wartime pace, it is producing horsepower in ever increasing millions. It is easier to criticize others for not doing more, than it is to do. A critic doesn't have to convert a plant overnight from peacetime to wartime production. He doesn't have to design and build tools and dies, make production schedules, train workmen, meet government specifications, and build a product that will pass the rigid inspection of the Army and Navy. And all the while he is working he does not have to be on his guard against talking about his accomplishments. The results are a military secret and have seldom been released. This is entirely as it should be if we are to prevent valuable information from getting to our enemies.

Let us go further and show what this war of horsepower means in the newest form of fighting machine, the airplane. Here the figures are just as astronomical as they are in the mechanized army division.

In World War I, a basic training plane used a 90-horsepower engine. This engine, the Curtiss OX-5, became the standard power for "barnstorming" after the war. The OX-5 engine weighed 375 pounds, or more than four pounds per horsepower Today a basic trainer uses a 200-horsepower engine weighing about 400 pounds, or two pounds per horsepower.



The author studies a new GM Diesel

THE most outstanding development has, however, come in the high-speed pursuit airplane engine. In World War I, the Liberty engine gained world fame and was to have become the standard high-output engine of the A.E.F. This engine developed 400 horsepower and weighed approximately 840 pounds, or more than two pounds per horsepower. It was just about the same size as the present-day liquid-cooled Allison engine which develops 1325 horsepower at less than one pound per horsepower. The development of the Allison engine was started by industry in collaboration with the army early in 1930, and it was just about ready for production when we needed it.

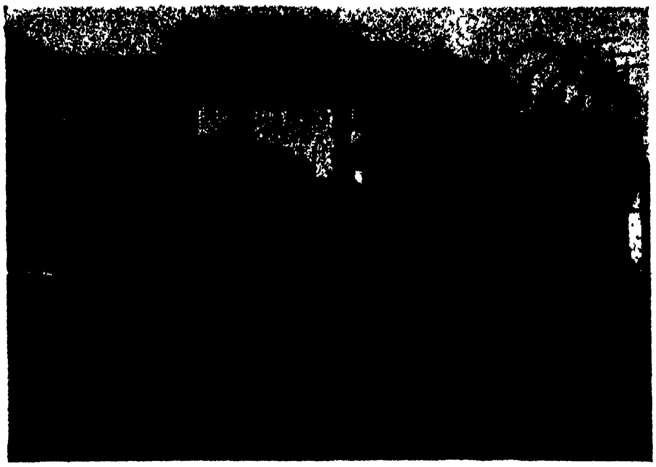
Far-seeing men in the United States Army asked industry to undertake this development even though there seemed to be no immediate use for the engine at the time. What is important to us now is that all the preliminary work was completed when the engine was needed. There is no way to speed up such development. Two hens can't hatch a setting of eggs any faster than one can. This is a fundamental factor that many people overlook.

The development of this new liquid-cooled engine has meant much to Army aviation. As a result of this development it was possible to increase the speed of a pursuit plane as much as 60 miles per hour on the same number of gallons of fuel per hour. It has taken only two years to increase its power from 1000 to 1325 without any significant change in the design, and this may be increased even further.

What does the huge air force the President asks for mean to us? He wants 60,000 planes in 1942 and 125,000 in 1943. Industry is being called upon to produce in excess of 100,000,000 horsepower this year and in excess of 200,000,000 in 1943 to power these planes. Let us do some more comparing and see what these figures mean. In 1942 we will have to produce as much power in aircraft engines as the combined power of all the railroads of the country. In 1943 we will have to double it. And this power will be for airplanes alone We already have a good start. One company alone is producing over a million and a half horsepower a month in a factory built where there was a vacant corn field only a year ago.

Today a pursuit pilot has from 1000 to 2000 horsepower to pull him through the air at speeds well in excess of 400 miles an hour. In World War I the 400-horsepower engine pulled him only about 120 miles per hour. Several developments have taken place to make these increases possible. First, the aeronautical engineer has learned more about the aerodynamics of the plane itself Better wing sections, streamlining, better materials, the reliable monoplane, retractable wheels, and dozens of other improvements have increased speeds.

But there is a limit to the increases that can be made by aerodynamics alone. It takes horsepower to fly at speeds of seven miles a minute. An engineer would say that the horsepower required goes up as the cube of the speed. In layman's language



Two Diesels operate this mobile power plant

Allison airplane engines being packed for shipment

this means that to get twice the speed we have to supply eight times the horsepower. Now we see why horsepower is so vital in obtaining air supremacy. Power means speed.

Fortunately engineers and chemists have given us the means of obtaining increased power from a given size engine by the development of better fuels. This means any engine that burns gasoline as a fuel, whether it drives an automobile, truck, tank, airplane, or motorboat High octane fuel makes our present high-output engines possible whether they are used for peacetime purposes or for those of war.

THE story of high octane fuels has been told many times The work grew out of my attempt to burn kerosene in a Delco Light engine long before we got into the First World War. The improvements which we effected in the fuel were made available to the automobile driver early in the 1920's Since then improved fuels have been responsible for doubling the power we get from an automobile engine Every driver of a car in the past 20 years has benefited from this development. It was a research project carried on by private industry and made available to motorcar owners in peacetime

The dividends which this single development has paid to our country have been enormous The automobile owner has saved about 25 percent of his fuel bill. This amounts to a billion dollars a year. It means also that we have conserved our natural resources. Better fuels have been responsible for just about doubling the output of a given size engine. It has been said that this has increased the installed power of automobiles by about one billion horsepower.

The T.V.A. is one of the foremost of our great power developments. This series of dams will produce about three quarters of a million horsepower, or less than one thousandth of the power gained by the use of better automobile fuels. If all our automobiles were to develop a "miss" in one cylinder at the same time, we would lose ten times the installed horsepower of all the T.V.A. dams together.

But what is extremely important to us at the present time is the fact that without these better fuels such powers and speeds as we require from our military planes would be impossible. It is not surprising that one man high in government office has said that high octane fuels may be the most important single factor in the outcome of this war.

In World War I the Liberty engine had to be designed to run on 50-octane fuel, the aviation gasoline available at that time. The Allison engine utilizes 100-octane gasoline The difference between the 400 horsepower of the Liberty engine and the 1325 horsepower of the Allison engine is largely due to this difference in fuel.

Because American industry conducted research during peacetime, we are the only country in the world with the capacity and the know-how to produce 100-octane fuel in adequate quantities for our military airplane engines. Fuel research has already added millions of horsepower to our armed forces.

A number of years ago we started a research project with the aim of developing a high-speed, light-weight Diesel engine. We had long hoped that we could bring the benefits in economy of the Diesel to the small engine field. We did not have any particular application in mind, for we knew that any new and better means for developing power would find hundreds of users Others would put the power to work.

In a few years a new type of two-cycle Diesel was introduced at the Century of Progress in Chicago. That was in 1933. The next year this type of engine was used to power the first of the new high-speed Diesel-powered streamlined trains. Likewise, the Navy had adopted it for submarines. This development of industrial research conducted by American industry in the regular course of its business has been found to be the answer to many naval and military problems Continued research has resulted in still smaller and lighter high-output Diesels. This family of engines is now powering naval craft of many kinds, large trucks and buses, tanks, and mobile power plants, all for war purposes. Here is an industrial research development which is useful either in peace or in war. The engine doesn't care what it is used to power.

ONE of the most important peacetime uses of the Diesel was in the new 2000- to 6000-horsepower locomotives This engine has revitalized the railroads and more Diesel locomotives are being built than any other type These efficient engines, which have speeded up switching, passenger schedules, and freight shipping, are of extreme importance in time of war We are deriving unexpected benefits from the speeding up of our war material deliveries made possible by this peacetime development. Diesel locomotives may even speed the deliveries of the same type of engine to be used by our Army or Navy for other defense purposes.

We are in a war of horsepower—of Allied horsepower against Axis horsepower The victory will go to the side which has the most and the best horsepower producers. American industry, which has produced the most peacetime horsepower, is now producing the most wartime horsepower Our front lines are the engineering departments, research laboratories, and factories. Able and experienced management, skilled workmen, and engineers second to none are holding these lines. All our efforts are geared to produce power and more power for the armies and navies of the United Nations.

This is a civilization of horsepower as well as a war of horsepower. When the engines of war have fired their last charge of fuel, the engines of peace will immediately start their job of rebuilding. We will not only beat the sword into the plowshare; we will convert the tremendous horsepower of war into the useful horsepower of peace.

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TIN PLATING

Thinner, More Economical

By New Process

Both tin and electric power will be conserved by a faster, more economical electrolytic process for plating strip steel with tin, announced recently by the Electroplating Division of E. I. du Pont de Nemours & Company. Known as the Halogen Tin Process, this process employs a neutral solution which is said to eliminate sludging and the consequent waste of tin common to many electro-tinning methods.

Strip steel for containers can be tin-plated twice as fast with less electric power by this process as by the "alkaline" electro-tinning method, it was stated, thereby reducing substantially labor and power costs. A thinner, more uniform coat of tin can be applied to strip steel electrolytically than by the conventional "hot dip" method, resulting in savings of from 40 to 65 percent of the tin used.

A larger percentage of tin cans henceforth will be plated by electrolytic processes because the War Pro- [illegible] Board has limited drastically the amount of tin for containers, and thin coatings of the metal will be necessary. Tin deposited by the Halogen process, it was said, can be heated without discoloration either when tinplate is heated to obtain the bright finish required by some can manufacturers or when treated during the process of applying lacquers or enamels.

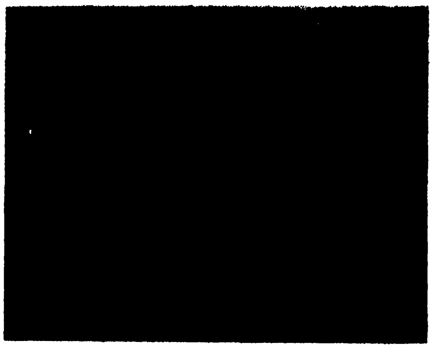
CONTROL

Of Production With

New "Scoreboard"

Busy industries in every classification, working on both war and civilian orders, are making use of a new system called "Produc-Trol" which enables production and purchasing executives to see quickly all facts concerning raw materials, parts, assemblies, machine and man hours. Information of this kind is especially essential where multiple-shift production is maintained.

"Produc-Trol", which was developed by the Wassell Organization, lists parts, assemblies, sub-assemblies, or individual operations at the left of the board shown in one of our photographs. Movable tapes working from left to right on pulleys bring all pertinent facts into instant focus. Double rows of peg holes under the movable tapes, and various colored pegs, permit many arrangements of comparative data and control, required for any operation. Units can be obtained in sizes to fit specific needs; models are also available for individual and group-incentive plans.



Keep tab on production

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MODERN INDUSTRY—Fifteen of the nation's major industries have been developed in the last 62 years, creating work for about 15,000,000 persons.

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METAL FINISH

To Substitute

for Plating

A colored transparent finish for use on polished metal, and which is unaffected by war-time restrictions, is being produced by Maas & Waldstein Company as a substitute for electroplating and bronze-powder finishes.

This finish, which is marketed as "Platelustre," consists of a concentrated enamel, of the desired color, added to a clear lacquer. When applied on polished metals, it makes them resemble copper, brass, bronze, color-treated aluminum and steel, or other metals.

It is applied by spraying or roller coating and can be furnished for either air-drying or baking. Flat stock finished with certain grades can be formed after baking. The colors are fast to light in indoor service, the manufacturer states.

CONVERSION

Of Machine Tools Calls

For Fine Ingenuity

Call it automotive "know-how" or call it conversion, the automotive industry has been faced for more than a year with the task of ingeniously adapting equipment for war jobs.

It was ten months or so before Pearl Harbor when one automotive concern, for example, agreed to produce parts for an anti-aircraft cannon In the loader mechanism of the gun, the automotive engineers and master mechanics found the greatest challenges to their ingenuity. This unit is an assembly of parts, most of which have to be machined in curves that are small segments of circles that range up to 86 inches in diameter.

Under normal conditions such cuts could have been made easily by huge milling machines with enormous rotary tables. But the smallness of the original order ruled out the possibility of using such special purpose machines. So an ingenious device was made—a fixture attached to an ordinary standard-type milling machine. It resembles a wedge of pie.

At the point of their "wedge of pie," the designers placed a fulcrum equipped with hand-screws. With this they could swing gun parts, clamped to the "piecrust," against the milling cutters.

With such unorthodox fixtures, most of the curved parts were machined for the original orders. And, having mastered the "know-how" on these ingeniously adapted machines, the master mechanics were prepared for the change of pace induced by the Pearl Harbor attack. The crisis brought the first large order for guns. They then transferred their "know-how" to similar adaptations of huge automotive rotary milling machines. These were torn down and rebuilt to make radial cuts in the large quantities required.

One of the large machines is now cutting radial loader parts, 17 at a time, out of huge hoops of bar steel.

Though no longer needed for the jobs they performed so ably, the small machines with their "fan-tail" fixtures have not fallen idle. Moved to another department, they are now executing radial cuts on curved airplane parts.—*Automotive War Production.*

INDUSTRIAL TRENDS

RESEARCH PAYS NOW . . . AND LATER

Substitute the drive of life-and-death necessity for the dollars-and-cents motive, and there appear amazing results from the research laboratory. That is exactly what is happening in many industries today, particularly in the automotive industry where production is all-out for war and not at all for the civilian consumer who has been the basis on which the industry has been built. In the calm days of peace-time activity, when the prime interests of the industry are to make a better product than competitors and at the same time show a reasonable profit, many of the findings of the research laboratory are at least temporarily shelved because their adoption would be too costly. But when the wheels must turn for military purposes and the profit motive is thrust into the background, the laboratory technician is in his scientific glory; no longer are costs the bugbears that hinder his development work. His main objectives now become the finding of new ways of doing things better and of new materials that, substituted for old ones, are at least as good as or better than the originals.

Before we become specific about this sort of thing, let it be understood that what has been said is not to be taken as an indication that war-time production is being used as an excuse for being wasteful. Far from it. But there is a definite job to be done and all too little time in which to do it. Under such conditions, many of the peace-time rules of industry are thrust aside and barriers are overcome by means that, given other circumstances, would throw the average cost-accountant into a quiet case of jitters.

Here's where it all stems from: As is too well known to bear repetition, there are real shortages in certain materials formerly considered indispensable in the automotive industry. Before the war—how long before makes no particular difference in this discussion—there had been developed many substitute materials for these indispensables, but they had not been put into production for economic reasons. Military approval of a substitute, however, ordinarily demands that the substitute be much more than a mere alternate. It must do its given job as well as the material formerly used; if possible, it must do that job better. This, indeed, is just what many of the shelved results of many research laboratories will do. So now these shelves are being cleaned off, their contents are being brought to light, and the labs are working night and day to produce the wherewithal for the production lines of victory.

Here are some cases in point, gleaned from *Automotive War Production:* Alloy steels containing carbon and molybdenum are superior substitutes for steels using nickel, chromium, and other scarce alloying metals, but these carbon-molybdenum alloys require heat-treating processes to bring out their superior physical properties. This heat-treating is too costly for ordinary commercial production in times when other alloying materials are cheap and plentiful. But when the life-and-death motive takes charge of the situation, all such considerations fall by the wayside. Thus, one company making small combat vehicles has saved 41,000 pounds of nickel on one contract by using these steels that research had produced but which had formerly been almost a laboratory curiosity. In another similar type of substitution, copper-silicon castings were substituted for the formerly used copper-tin alloy in the manufacture of anti-aircraft guns; net saving was 20 pounds of tin per gun.

Then there is the case of sheet steel, one of the forms of metals that has relatively little use in wartime production. A shell clip was formerly made by die-casting aluminum. It was decided to change the design and to use sheet steel. Result: An improved clip and expanded use of sheet steel, together with employment of men and machines that work this material. Also, the change-over in this clip alone is reported to have saved, to date, $2,000,000.

Metals are by no means the only materials which are receiving the utmost attention of researchers. Leathers, fabrics, and felts have been developed as alternates for the rubber and synthetic rubbers that were formerly used in anti-squeak pads, bumpers, gaskets, and seals. Plastics have been put into service in steering wheels, replacing the hard rubber formerly used. Other similar plastics, in extruded form, have found application in cooling-system and other hoses. Battery boxes of molded natural asphalt found in Utah are releasing still more rubber.

And so it goes. To summarize: In one combat vehicle, original plans called for 12 pounds of rubber, exclusive of tires. Alternate materials have cut this rubber requirement to one half pound. Another vehicle has been redesigned to use alternates, with the result of saving more than 16 pounds of rubber and almost five pounds of nickel per unit. These brief figures give a graphic idea of what has been accomplished. What this trend — and it extends throughout all phases of vehicle design and construction —will mean to the post-war automotive industry is quite obvious. No one knows today what the civilian automobile will look like when the industry starts after customers instead of after Japs and Nazis, but we can all rest assured that it will have better materials and greater efficiency than ever before.

DIAMONDS OF INDUSTRY

Although the use of diamonds in a variety of industrial tools is not by any means new, such tools as were used in the United States were largely imported from Europe until the outbreak of World War II. Now, faced with the need for precision machine work in so many war industries, diamond cutters and merchants in this country are turning to this outlet for their products and are building a business that is one of the most rapidly advancing industries of the moment. It is worthy of more than passing notice, also, that jewelers are advocating the purchase of gem stones for personal adornment on the ground that the by-products of cutting such stones are small diamond chips which can be used in industrial tools. Thus, they argue, the more gems purchased, the more chips there will be for use in the war effort and, at the same time, the less costly will be these same chips to those who need them.

But larger sales of gems is not our concern: What is more important to the trends of industry is the fact that industrial diamonds are needed and are being supplied in ever-increasing quantity and for ever-expanding uses. Because diamonds are the hardest substance known, they are widely used not only in grinding tools but in dies and gages as well. So hard is the diamond, in fact, that dies and gages are being supplied to industry today with guaranteed tolerances of hundreds of thousandths of an inch; in some cases with no tolerance at all! With such American-made tools available, all industries demanding high precision can put their best efforts forward.

—The Editors

Synthetic Elastomers

How Molecules are Manipulated to Make New Rubber-like Materials in Unlimited Variety

SIDNEY J. FRENCH
Professor of Chemistry, Colgate University

● In our April 1942 number Professor French explained, by means of little sketches or "models" similar to those used in the present article, how the chemist makes higher and higher octane gasolines. In the present article he explains by means of similar models why rubber is elastic, and why the rubber chemist's modern knowledge of the secrets of manipulating moleclues enables him to design and make synthetic elastomers (rubber-like substances including rubber). The little drawings are not, of course, offered as precise representations of atoms and molecules, especially as the precise nature of these entities remains in part unknown. Science does know that atoms are not neat little circles or balls with little fishhooks attached, but it also knows enough about their arrangement to be sure that such conventional models represent their approximate nature. At least, as practical representations these structural formulas serve our purpose in explanation and in every-day use.

Professor French is the author of the recently published books, "Torch and Crucible" and "The Drama of Chemistry," chosen from many popular chemistries to run serially in The Dow Diamond, the magazine of the Dow Chemical Company—the first issue of which appeared in January.—The Editors. ●

SEVEN hundred thousand tons of synthetic rubber by the end of 1943—to be produced in American factories as yet unbuilt! The world has never before had ring-side seats at such a stupendous undertaking in the translation of science into stark necessities.

Can it be done? Had that question been asked before December 7, 1941, the answer no doubt would have been an assured and cocky, "Yes, if we were put to it!"

Today we are put to it in no unmistakable manner. What is the answer now? There is less cockiness, more seriousness, as there always is when a boast must be turned into a result. But the answer is still, "Yes!" Either we produce synthetic rubber or we go down to defeat. Planes and tanks must have rubber—an amazing amount of it. So must soldiers, cannons, and battleships. In such a diversity of items as raincoats, boots, tires, pads, gas masks, surgical gloves, hose, de-icers, gas tanks, insulation, storage batteries, and on up to 2000 or more items, rubber plays its essential part in war.

Had we faced today's crisis a decade ago, we would have been helpless; we did not know how to make satisfactory synthetic rubber. Today, we do know how; not only do we know how but we are already producing it in modest amounts—not one kind but more than two dozen types of this strategic material.

East Indian natural rubber is out for the duration—possibly forever. It provided 97 percent of our rubber products. Talk of developing the Mexican guayule shrub or any other[1] rubber-yielding plant in time to meet our urgent needs is wasted breath For the long view such investigations may be worth while but not for tomorrow's view.

It can, of course, be argued that the proposed gargantuan expansion in synthetic rubber is equivalent to pouring money down the neck of an industry due to choke of its own weight after the war when it must face the competition of natural rubber. Perhaps so, but it is costing us only the price of a couple of dreadnoughts, even were we to lose all of it. We expect to lose battleships, and we must be prepared to lose our investment in synthetic rubber. That we shall lose it, however, is far from certain; such mass production is bound to lower the price of synthetic rubber to a point where it may be able to meet the price set on its natural rival even in peace time. Furthermore, some of the synthetic varieties possess properties not found in natural rubber, and will supplement rather than displace the natural material.

During the 1930's, Herr Hitler boasted at least three times that his scientists knew how to make synthetic rubber. Of course, he was 50 years behind the times, since the first synthetic rubber had been prepared — more or less by accident—in 1884. He had even forgotten that the Kaiser's scientists had developed a synthetic rubber—not one to boast much about, however—during World War I. Finally, he conveniently overlooked the fact that the first successful commercial synthetic rubber was developed in the United States and appeared on the market in 1931.

THIS product was neoprene, the brain-child of a modest but brilliant scientist-priest, Father Julius A. Nieuwland[2] of Notre Dame University, and the equally brilliant Wallace Carothers and his associates from the Du Pont Chemical Company. Together they wrote the pages of a fascinating story which translated the findings of theoretical science into the production of thousands of tons of neoprene. Without doubt, before the manuscript for the present article is finished, many of its superflous words will have been erased—with a neoprene eraser. Without doubt this eraser will have to last for several years. Fortunately, it will; because neoprene does not age like natural rubber. That is one of its important and useful qualities.

Today, 11 years after neoprene hit the market, it is still important and growing but it no longer holds the stage alone; it has some 28 competitors and associates to spur and comfort it. Not all of these 29 varieties will prosper but many of them will. Some are so new that we know little about them as yet. In the year 1940 alone, six new American varieties of synthetic rubber were introduced to the public.

With this great array of new elastic materials and new names to bewilder us, the scientists have decided that they must scrap the all-inclusive term of synthetic rubber. These materials are *not* rubber, but rubber-like. To be in the van, we must now call anything whose nature is elastic an *elastomer*, whether it comes from the rubber tree or the test tube. Hence, we have natural and synthetic elastomers.

The all-important question is, how are these synthetic elastomers made? But before attempting to answer this, we had best find out how nature's elastomer is made. This is the path of all science—and of most any other endeavor, for that matter. First, we study existing models, tear them apart, analyze the construction; then we attempt to build as the model is built; finally, we branch out, modify and change the model more nearly to suit our needs.

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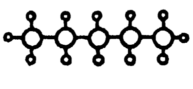
[1] A systematic survey of these plants—the Madagascar rubber vines, milkweeds, Russian dandelion, goldenrod, rabbit brush, and osage orange—prepared by the United States Department of Agriculture, appeared in Scientific American last month, pages 276-277. This survey concurred with the above-stated opinion of the author: reliance on any of these emergency plants is wishful thinking.—Ed.

[2] A two-page article on neoprene, by Father Nieuwland, appeared in the November, 1935, number of Scientific American.—Ed.

The scientist has known since 1860 what kind of units rubber is built of. The trouble was that he knew neither how to make these units nor how to fasten them together. It has taken him three score years and ten, the lifetime of a man, to learn these tricks which, now that we comprehend them, seem rather simple.

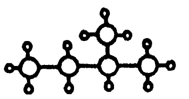
Natural rubber, and most synthetic elastomers, are substances known to the chemist as hydrocarbons. Translated, this means that a rubber band is composed of billions upon billions of tiny, invisible carbon atoms, plus more billions of hydrogen atoms. Yet, for that matter, gasoline, kerosene, mothballs, benzene, and a host of other substances are also hydrocarbons. So the secret of rubber lies not in the mere fact that it is a hydrocarbon. Rather it lies in the manner in which these carbon and hydrogen atoms are hooked together—in the architecture, in the pattern.

What is this pattern so essential to rubber? It is a simple one, fortunately, yet it is as full of potential surprises as a treasure chest. The chemist knows full well the unique habits of carbon atoms. They tend to string along like cranberries in a Christmas chain—and each carbon atom is decorated with smaller hydrogen atoms, like glass-headed pins stuck in to add to the gaiety. There is one sacred rule which no chemist dares disobey. In his model, each carbon atom must, somehow, have four attachments, and these must be distributed between its neighbors in the chain and its attending hydrogen atoms. Thus, we can build our cranberry-pin model of a hydrocarbon as follows:

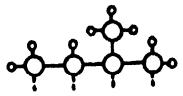


This fellow, called pentane, happens to have five carbon atoms in the chain, but the number five is not sacred; we might have more, or less.

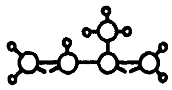
As long as we preserve our sacred rule of four attachments, we can do most anything we wish with this molecule—on paper at least. For example, we might pull a berry off one end and place it on the side of the chain, the berry trading places with a hydrogen "pin," thus:



Now let us behead the four bottom pins, thus:



We have disobeyed the sacred rule! We have left one attachment, or bond, on each berry, waving in the air, tied to nothing. This cannot be. Compromise is a rule of molecules as well as of life, so the waving bonds, finding nothing better to do, tie up with one another in the following pattern:

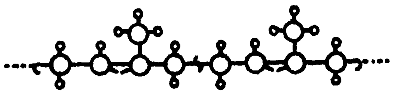


Fortunately, for the existence of rubber, these extra bonds are quite unhappy and superfluous. They are the stags at a dance, ready to flit away in search of a better partner, tolerating their union as a makeshift arrangement only.

This lop-sided molecule with its extra stags is a very famous one. It is isoprene, the "rubber brick," the unit of which all natural rubber is composed. The chemist prefers to call it by its generic name of methylbutadiene. And, contrary to popular belief, such a name is not mere gibberish; it gives to the chemist an exact picture of the molecule and its parts. The confusing thing is that he writes it without hyphens, as though he were to write, "the-house-by-the-side-of-the-road" as "thehousebythesideoftheroad." Methyl means a carbon atom with three attached hydrogens. Buta means a four-carbon atom string. Di means two. Ene means stags or, more technically, double attachments. Thus, we have a methyl group tied to a buta chain containing two double attachments.

When we have molecules of methylbutadiene, we by no means have rubber, any more than we have a Paul Jones dance when we have an assortment of people all with hands in pockets. We must get these molecules to join hands, and this, of course, is where the stags enter the picture. Without them, there would be no hands to join—and no rubber. But before this joining of hands can take place, there must be proper introduction. Finding the proper introducer is no small task. It has been, and still is, one of the most difficult jobs of the budding synthetic elastomer industry.

Once this important personage has been found, the rest is easy; each methylbutadiene molecule links up with a neighbor, end to end, as is illustrated, the necessary stags swinging around to meet those from each neighboring molecule:

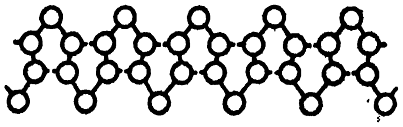


When billions upon billions of these molecules become linked in this manner, we have a rubber fiber. But notice what has happened. Not all the stags could participate in this Paul Jones affair. Two stags in each molecule are still left disconsolate. They pair off in the middle of each "brick." Perhaps we can provide suitable partners for them yet.

Just why should this linking of molecule to molecule in such a manner give a substance which can be stretched to several dozen times its original length and rebound once more when released? With all the exhaustive work they have done on rubber in a century, the chemist and the physicist together are still unable to give a complete answer to this question. But they have several very good theories. They know, for example, that long molecules built up in this way are not straight, but coiled like a spring But this is true of any long carbon chain molecule, yet not many of these have the stretch of rubber. We must look elsewhere for the complete answer.

The X-ray has shed light on many a scientific problem; it sheds surprising light on the structure of rubber. When X-ray photographs are taken of crystals, the positions of the very atoms themselves are exposed and these positions reveal a perfect regularity of pattern. In a liquid, on the other hand, we get only a smear, indicating that the molecules are gloriously and irregularly mixed. Under the X-ray, relaxed rubber behaves like a liquid, stretched rubber like a crystal. Is relaxed rubber, then, a liquid? Well, the scientist is inclined so to regard it. The atoms are so gloriously mixed that they do not know to which molecule they belong. For this state of affairs we can no doubt thank the remaining stags. In their search for partners, they reach out to take hold of atoms further up the chain, out of line, so to speak. In doing so, they cause the long string to fold back on itself somewhat like a folding ruler.

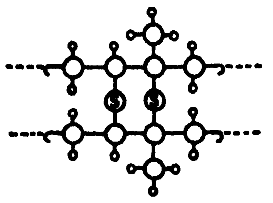
We might picture it thus, showing only the spiralled carbon chains and the stags (in dotted lines) holding the folds loosely together:



When the rubber fiber is pulled, the stags give, like tiny springs, the molecules are literally stretched into shape and the X-ray. reveals a crystal pattern. Actually, the scientist believes that the rubber units sort of fold into, and dissolve in, one another when the rubber is relaxed.

In the year 1844, United States patent number 3633 was issued to Charles Goodyear on the vulcanization of rubber with sulfur. This is the patent which brought about at one and the same time the most famous lawsuit of the century and the great rubber boom. Pitted against the oratory of Rufus Choate, Daniel Webster won the suit for Goodyear. But, regardless of who won the suit, the case for rubber has been thoroughly established. Without sulfur, rubber is soft, pliable, and has little tensile strength. When sulfur is added, we obtain products ranging in stretch and hardness from the rubber band to the hard rubber insulator. Why this amazing shift and range of qualities upon mere heating with sulfur?

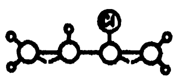
Perhaps you have guessed it. The stags once more! These remaining stags are delighted to join hands with sulfur atoms, each sulfur atom — S within a circle — taking on two stags as shown:



Thus, we have several fibers of rubber joined together — braced, as it were, by sulfur atoms. Each fiber lends its strength to the other. No wonder the tensile strength goes up. But the stretch goes down, because the stags are no longer available to tie fold to fold. If we put in just enough sulfur to use up every second stag, we can still have some fold and stretch left, but if we put in enough to use up all the stags, stretch is gone and we have brittle, hard rubber. It is little wonder, then, that we can get almost any combination of stretch and hardness by varying the sulfur content. There are, of course, many other substances, such as zinc oxide and carbon black, which play important roles as fillers and hardeners in rubber.

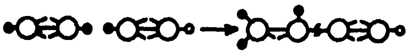
Little enough has yet been said about synthetic elastomers but, in reality, little need be said about them. The principles, with a few modifications, which apply to rubber also apply to synthetic elastomers. Once we knew what kind of molecules composed rubber, and how they were linked together, we could go about building synthetic materials along somewhat similar lines.

Neoprene is composed of units of chlorbutadiene — you have guessed it: a molecule of neoprene differs from natural rubber only in having a chlorine atom (Cl within a circle) in place of a methyl group, thus:

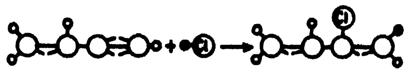


It is as though we had placed a cherry on a cranberry chain. This chlorine atom gives to neoprene several surprising characteristics. The stags are now so active that no introducer is necessary to unite the molecules into chains; they do it of their own accord. The remaining stags then cross-tie the strings into strong bundles of fibers. Vulcanization is unnecessary and, in fact, impossible in neoprene.

The source materials for neoprene are abundant and cheap. Acetylene molecules join hands to form vinylacetylene:



(Notice how some of the hydrogen atoms — those shown in black — have shifted to effect this union.) Vinylacetylene then reacts with hydrogen chloride to form chlorbutadiene:

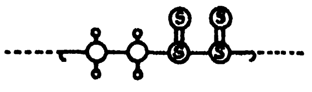


(Notice how the stags have been reduced in number by these processes.). The chlorine comes from salt. The cost is in the manipulation, not the materials.

The German synthetic elastomers about which Hitler boasted so loudly are known as Buna S and Buna N. Both are made from butadiene, but not from it alone. Interspersed with the butadiene molecules in Buna S are styrene molecules, somewhat complicated, but possessing the ever necessary stags. To introduce styrene to butadiene, the metal, sodium, is used. The chemist's symbol for sodium being Na, you have the origin of the name Buna S — Bu- for buta chains, na for the sodium introducer, S for styrene. In Buna N, acrylonitrile (N) takes the place of styrene.

Before succeeding in making these alphabet bunas, Hitler's scientists had succeeded in making plain bunas (butadiene molecules strung together). These early perbunans—note the derivation of the name—were almost as bad as the Kaiser's cumbersome elastomer in World War I. But the alphabet bunas are of high quality. They can be vulcanized, have high tensile strength and resistance to wear. The raw materials come from petroleum buta- chains — often previously wasted — resulting from the manufacture of gasoline. With our vast resources of petroleum, it is little wonder that we stand ready to lead the world in making all types of buna elastomers. And it is for these products largely that our great government-endowed expansion program is planned. Already the American public has met three such brands: Ameripol, Hycar, and Chemigum. It will meet many more in the near future.

Now that we have learned how to make stagged molecules and to hook them together, we are no longer limited even to hydrocarbon chains. Thiokol (thio means sulfur) elastomers have sulfur atoms right in the chain. Here is a model unit of a thiokol elastomer



made from acetylene and sulfur. There are at least three commercial varieties of thiokol on the market.

Then, there are elastomers which are neither entirely fish nor fowl. They are hybrids of elastomers and plastics. They lack the stretch but have the great flexibility and water proof qualities necessary to make them useful in hundreds of ways. Such a product is Koroseal, made from acetylene with chlorine as the introducer.

Finally, another group stemming from petroleum, the butyl elastomers, is fast coming upon the scene. As yet, we know little about these products but they show great promise.

Delighting in high-sounding names — which, nonetheless convey real meaning to him — the chemist dubs these endless molecules, made by the joining of hands of numberless small identical unit molecules, polymers. If the small molecules are not identical, the product becomes a copolymer. The process is polymerization or copolymerization.

The great significance of polymerization is not so much that we have at last learned how to make these synthetic elastomers, important as that may be in these grave days; it is that we have mastered the secrets of making these stagged molecules, of finding the proper introducers, of building endless molecules to *our own specifications.* We have just made a start, and at present we are still trying largely to imitate the qualities of natural rubber.

But there is no apparent limit to the diversity of products which we may obtain through copolymerization. We may go on building these experimental endless molecules till we find some that far surpass natural rubber in elasticity, some that surpass it in wearing quality, some that surpass it in weathering quality, and in resistance to tear. So we shall have, eventually, not a single imitation of nature's product but thousands of new useful products, each with its own valuable qualities, adapted to its own particular uses.

Nor will we stop with these diversified rubber-like materials. After all, elastomers and plastics belong to the same great family of polymers and copolymers. We shall go on mixing the breeds till we have produced elasto-plastomers and plasto-elastomers almost without end and with every conceivable gamut of qualities.

And for our starting materials all we need are limestone, coke, water, sulfur, chlorine, and petroleum. There is no shortage of these in America!

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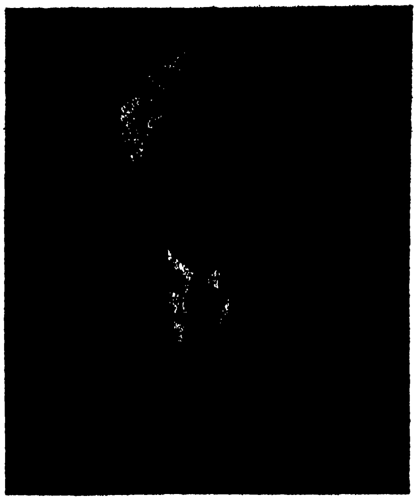
BEST WAVELENGTH

For Short-Wave Communication Can Now be Predicted

Automatic recordings of electrical conditions in the upper atmosphere now make it possible to predict with accuracy the best frequency to use for short-wave communication at any given time. The automatic multi-frequency recorder used for this work is a development of an "echo" technique for investigating the ionosphere, the radio-reflecting layers of the upper atmosphere whose heights affect short-wave radio.

Personalities in Science



SIR C. V. RAMAN

At Trichinopoly, in Southern India, Chandrasekhara Venkata Raman was born on November 7, 1888. He received his early education at the Hindu College, Vizagapatam, where his father was a Professor of Mathematics and Physics. Later, he studied for four years at the Presidency College, Madras. He graduated from this institution at the age of 16, and two years later took his master's degree, in both cases with the highest distinctions. Even as an undergraduate at the Presidency College young Raman displayed his genius for original research and independently carried out his first investigations in optics and acoustics. His capacity for scientific research greatly impressed academic circles at Calcutta and led to his being invited by the University of Calcutta to accept a newly endowed chair of Physics. In April 1933, Raman left the Calcutta University and accepted a call from the Indian Institute of Science at Bangalore, where he now works.

The research papers published in the last 20 years by Raman, and collaborators in his laboratory, include over 600 titles and concern themselves with a variety of subjects such as the dynamics of vibrations and sound, the theory of musical instruments, diffraction problems, meteorological and colloid optics, X-ray diffraction in liquids and solids, magnetism and magneto-crystallic action, electro- and magneto-optics, photo-elasticity of solids and fluids, dielectric behavior, and ultrasonics. By far the best-known work of Raman is his discovery early in 1928 of the new radiation effect known by his name and which was the natural culmination of the investigations on the scattering of light, systematically conducted in his laboratory since 1921. The 14 years that have elapsed since the discovery of the Raman effect have witnessed the fulfillment of the confidently expressed hope of the discoverer that it would throw new light on many problems in physics and chemistry. Several thousand papers have now appeared on this subject, but the possibilities of further advances in both physical and chemical applications are far from being exhausted.

Impressive though his own personal contributions to science have been, Raman's greatest achievement in his leadership in the renaissance of science that has been taking place in India during the past quarter of a century. The progressive enthusiasm for scientific studies and research that exists in India today has largely been inspired by him and encouraged and sustained by his efforts. His personal example of self-dedication to a scientific career, the brilliance and originality of his researches, the international recognition that his work has received, his gift for eloquence which has served to stimulate a widespread interest in science, his achievements as a scientific administrator in creating facilities for research and establishing new schools of science, and his success in founding journals for publication of scientific work in India are among the factors which have profoundly influenced the progress of science in that country.

The world was not slow to recognize the importance of Raman's achievement as an investigator and a leader of scientific research. Scarcely had he completed six years as a Professor of Physics when the Royal Society of London elected him a Fellow in 1924. He was knighted by the British Government in 1929. He was the recipient of the Matteucci Medal of the Italian Society of Sciences in 1928, of the Hughes Medal of the Royal Society in 1930, and in the same year he was awarded the Nobel Prize for Physics.—*Dr. W. F. Meggers, National Bureau of Standards, in the* Journal of the Optical Society of America.

A Pier in Time—

Psychology Joins With Engineering Skill to Produce a "Hospital" Pier in Record Time of 43 Days

A. D. RATHBONE, IV

Driving creosoted piling into the chill waters off the rim of Staten Island, in New York harbor, during late February and early March, is no job for a sissy. But there weren't any sissies in the 120-man pier-building crew of the George W. Rogers Construction Company. Mostly husky, raw-boned, taciturn Scandinavians and Finns—men to whom the words Oslo, Stockholm, København, Helsinki meant members of families still in Nazi-occupied, influenced, or threatened countries—this gang of burly workmen spoke little, drove hard, and completed a 700-foot utility pier for the United States Navy in the record time of 43 days as part of their contribution to beat the Axis Powers.

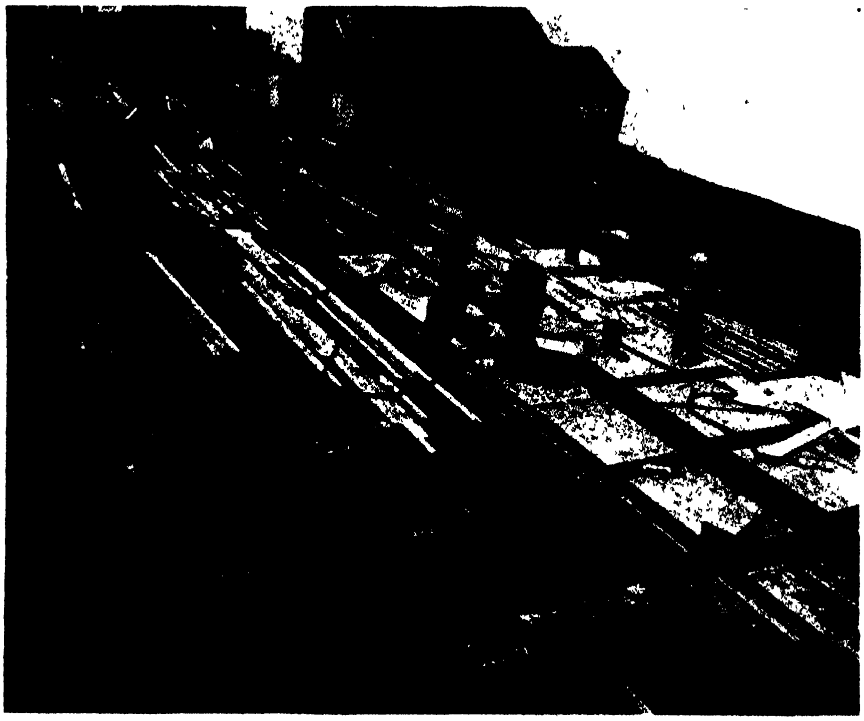
Prosaically known as Pier 10, this engineering job forms the final factor of a three-part unit comprising a ship-launching way flanked by fitting-out piers, Numbers 10 and 11, in the Bethlehem Steel Company's yards, and is unique not only for the necessary precision maintained during the speedy building of the unit, but also for the somewhat novel method of construction. The shipway, designed by Lockwood Green Engineers, Inc., has an unusually heavy concrete deck carried directly on the heads of the piles, which extend six inches up into the slab.

As it was considered undesirable to break the creosoted skin of the piles by nailing stay-laths to them, a hanger system was devised by using Richmond tie hangers carried on sections of light rails, which in turn rested on the heads of the pilings. On this suspended framework the criss-crossed reinforcing steel rods were laid and hand wired at approximately a million separate crossing points. The forms were then constructed and, with the above method of suspension, proved to be satisfactorily stiff and solid. "High-early" strength, pre-mixed concrete was poured, at some points under pneumatic pressure, and such was the speed on the job that, with the quick-setting cement, trucks could be and were driven over the deck 24 hours after pouring. The deck on this shipway varied from 12 to 25 inches in thickness, being generally 12 inches at the sides and 24 inches under the keel blocks.

The piles for Pier 11, which was constructed first, 72,500 linear feet of them—about 13.5 miles—were driven by floating pile drivers equipped with 75-foot leads and Vulcan Number 1 steam hammers. It was necessary to force the pilings through some 12 feet of mud, then to penetrate 12 to 14 feet of hard material — clay, sand, and gravel—before reaching the underlying strata of rock. The nicety and accuracy of the job can be realized when it is known that the piles were shaved to a specified level and the general surface line-up graded by surveyors.

In the middle section of the launching way, after the piles had been driven and batter piles placed both ways longitudinally, riprap was placed in an area 60 feet square to resist the thrust during launching. The outer end of the way was built of creosoted wood for a distance of 84 feet. This wooden apron extends from about half-tide to a point two feet below low water, and here the construction work was accomplished largely by employment of a crew of divers.

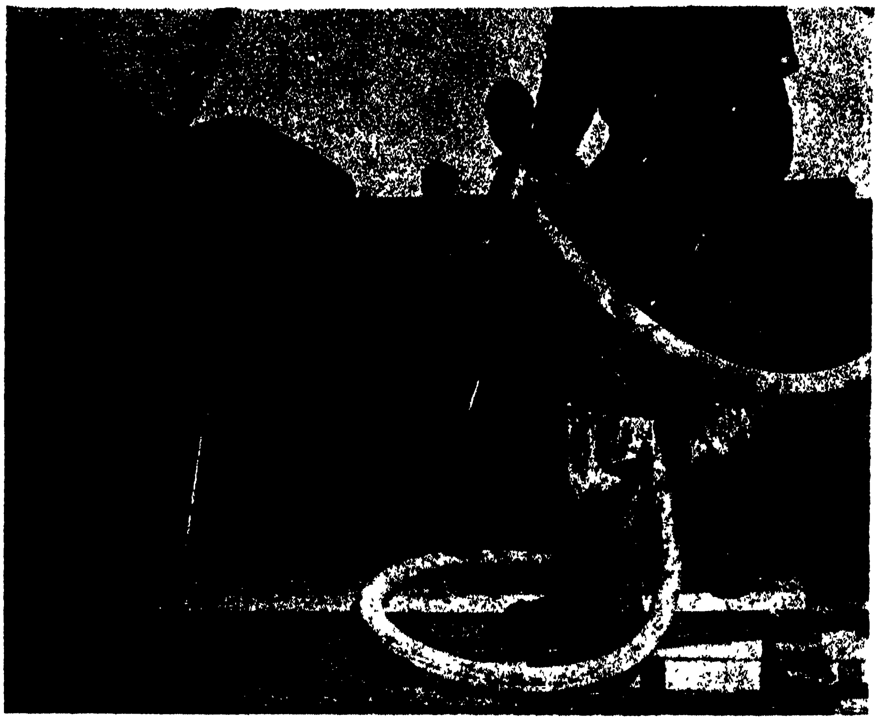
More than a million wired joints, each twisted with special anti-Axis gusto, went into preparation of framework



A crew of Scandinavians and Finns, moved to extra efforts by thoughts of home-folk in occupied countries, rushed construction of "700 Feet Toward Victory"

Although the shipway and one of its flanking piers were completed sufficiently ahead of schedule to permit laying the keel of a ship nearly four weeks earlier than planned, all that happened last year, before Pearl Harbor. Then the Bethlehem Steel Company and the Navy informed George W. Rogers, President of the firm that bears his name, that his original estimate of 90 days for completion of Pier 10, the final unit in this group, would have to be cut to 45 days. Inasmuch as this was a lump-sum contract and not on a cost-plus basis, the speed-up proposal, however much it might mean in our shipbuilding program, was something for any contractor to conjure with.

HOWEVER, Rogers, whose grandfather began building piers for the government in 1869, and whose father continued the family construction tradition during World War I, has been doing things with men, and steel, and concrete since he, himself, finished his trick in the Navy in 1919, and he said he believed it could be done.


Such was the speed-up on the Pier 10 job that at one time cement was being poured at shore end of the pier while piles were being driven at outer end

There were, inevitably, some temporary shortages of material, although everything possible was done to prevent hold-ups, even to trucking special loads of piles from as far away as Wilmington, Delaware. "At one time," reminisced Mr. Rogers, "we were pouring cement at the inshore end—which was then virtually completed—while we were still driving piles at the outer end—a crazy method to run a pier job, but there just wasn't any other way."

Despite a scarcity of skilled dock builders, the 700-foot-long Pier 10, composed of 42,700 linear feet of creosoted piling, 200,000 board feet of creosoted timber, and 22,700 square feet of concrete, was completed in the unprecedented time of six weeks and one day. The work was done on a two-shift, seven-days-a-week basis, and although flood-lights shone over the cold, black waters to help the night shift, all driving of piles was done in the daylight for the sake of safety. Before the concrete of the deck was poured, huge H-beams were placed horizontally at their specified points, with no deviations allowed. The rails on which the 100-foot-high cranes move back and forth astraddle of the ship, lifting and placing armor plate, turrets, or heavy guns, were laid over the H-beams. At the dedication ceremonies both cranes were on their rails.

One of the cranes has a capacity of 15 tons and the other can handle 20 tons. A unit of two outfitting piers, such as numbers 10 and 11, and the shipway they flank, has aptly been referred to as "hospital piers," for here all manner of shipbuilding operations may take place. They may be used to graft machine guns, cannon, additional armor plate protection to a merchant vessel in the course of its conversion to some type of warship. Newly launched hulls may receive what it takes to make a fighting ship strong and powerful. "When a ship's battered," says Rogers, "it needs a hospital. When you have guns, tanks, planes, you need ships to take them places. No piers—no ships."

Night and day, many tons of "high-early" strength premixed concrete flowed into forms in a steady stream

To commemorate the completion of this Navy utility pier in the record time of 43 days, 25 days less than the previous record, a bronze plaque was sunk into the newly poured last yard of concrete deck, and the entire job has been looked upon as something of a barometer of wartime co-operation and effort.

REALIZING today's urgency for this type of construction in our shipyards and knowing his Scandinavians and Finns for what they were, Rogers combined psychology with engineering knowledge. He mingled freely with them at all hours of the day and night, asked them what they heard from their folks in Norway, Sweden, Denmark, Finland. It worked! Tight-lipped, they replied little, but seemed to delight in venting pent-up emotions on the huge timbers and steel beams, on the tangled reinforcing rods and ever-flowing concrete. They hung up a sign designating Pier 10 as "700 Feet Toward Victory," and with this brand of co-operation and the simultaneous co-ordination of suppliers of materials, Rogers' promise to the Navy and to Bethlehem Steel Company was fulfilled.

RW Tauri

A Remarkable Eclipsing Variable Star with a Gaseous Ring Whirling About One Component

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

An unusually interesting piece of news (now published in a technical journal, and hence available for these columns) comes from Dr. Joy at Mount Wilson. For years this veteran observer has been following eclipsing variables with the spectrograph, and measuring their radial velocities. This is scientifically remunerative, for if the orbital motions of both stars of a pair can be recorded, the real dimensions of their orbits, and the actual sizes, masses, and densities of the two stars can be calculated. But it is also very laborious, for the bright stars of this interesting type have long ago been worked up, and the faint ones demand long exposures.

In some of the most interesting systems, the star of larger diameter is fainter than the other, and the eclipse is total. By observing while the small bright star is completely hidden, we may then study the spectrum and motion of the larger without disturbance by the light of its much brighter companion — which, when both are visible, drowns the other out completely.

To work up such a problem demands great patience, for the total eclipses last at most a few hours, while the intervals between them are measured in days. For a large percentage of the eclipses, the star will be below the horizon, or too near it to be observable. More than half of the rest will come in the daytime, or twilight. On the average, fully three quarters of the eclipses will be unobservable for these reasons.

In a great observatory, where the time of the telescope must be divided among many astronomers, a considerable part of the possible chances will come on nights when the instrument is equipped for some quite different type of work, or when the moon is "wrong." This cryptic remark means that some types of observation—such as direct photography of faint nebulae—can be done only on clear, dark nights. Moonlight, which drowns nebulae out altogether, does not bother the spectroscopist, since little or no moonlight gets through the narrow slit of his spectroscope, upon which he keeps the star-image centered. The dark of the moon is therefore sacred to the nebular program, and certain others, while spectra are photographed when the moon is bright. Two spectroscopic observers may, and frequently do, exchange nights when one of them has something of exceptional interest, but a general indiscriminate exchange of working hours is impracticable.

When the long-awaited eclipse comes at last on an available night, it may be cloudy — even in the best of climates — or, though the stars are visible, the irregular refraction in our atmosphere, known as "bad seeing," may enlarge the image of a star so much that only a small fraction of its light gets through the slit of the spectroscope.

For an ordinary star, this necessitates a much longer exposure — which diminishes the total amount of the night's work, but not the value of each plate. But, when the eclipse is short, and the star faint while it lasts, the lengthened exposure may run over the time allotted by nature. The observer, realizing that he can get only a blend of total and partial eclipse, which he does not want, will regretfully turn to some other star on his list, and hope for better luck next time.

RW Tauri—the star here discussed—is peculiarly laborious to observe. Normally of magnitude 8.1, it drops to magnitude 11.5 at intervals of 2^d 18^h 45^m. The fainter component obscures the brighter one completely for only an hour and 20 minutes—less than one fiftieth of the period—so that the chance of finding it faint at a random glance is very small, and the observer who wishes to study it at minimum, though provided with accurate predictions of its occurrence, must waste no time. During the total eclipse, the photographic brightness is nearly half a magnitude fainter than the visual, showing that the companion is reddish. At this time, when the glare of the bright star was cut off, Joy discovered a visual companion of magnitude 12.5, at an apparent distance of $1''$ from the variable. Small as this seems, it must be several thousand times the distance which separates the eclipsing pair, and it will be many years before it can be determined whether this companion is really related to the variable, or merely in line with it, but much nearer or farther away.

Allowing for the light of the third star, it is found that the larger component of the close pair emits but 1/36 as much light as the star which it eclipses. Only one or two cases of greater disparity in brightness are known. To get a spectrum of a 12th magnitude star showing good detail in so short a time demands very powerful equipment. Only the 100-inch reflector is really equal to the task; but with this Dr. Joy has secured several spectra during totality on different nights, some with exposures as short as 45 minutes.

These plates show a spectrum of Class KO, (similar to that of Arcturus) with well defined lines, while those taken outside eclipse show an equally well defined spectrum of Class B9 (corresponding to a star a little hotter than Vega) belonging to the brighter star, which drowns out its fainter companion completely. The great difference in temperature between the two stars accounts for the difference in brightness.

Many other totally eclipsing pairs are known, in which the difference in brightness, though large, is less than for RW Tauri. The distinctive peculiarity of the system is that, at the time of total eclipse, remarkable bright lines appear in the spectrum. These were observed by Wyse at the Lick Observatory in 1933, but not followed up until Joy's recent work.

A spectrogram taken in 1940, with an exposure of 65 minutes, covering almost the whole duration of the minimum, showed that the hydrogen lines, $H\beta$, $H\gamma$, and $H\delta$, were bright and widely double. The two components of each line were shifted equally far to the red and to the violet of the normal positions, by amounts corresponding to velocities of 350 kilometers per second in each direction. Fainter emission lines of ionized magnesium, calcium, and iron were also observed on this and later plates.

This enormously wide doubling of

the emission lines cried aloud for explanation; and this was forthcoming when observations during the total eclipse were made during 1941.

These show that if the exposure was commenced as soon as the eclipse became total, and stopped at or near its middle, only one of the two emission components was visible for each line, namely, the one on the side toward the red. For an exposure beginning at mid-eclipse, and continued till close to its end, only the bright lines on the violet side of the normal position appeared; and, upon a plate taken during the middle of the eclipse, there were no bright lines at all. The first plate, with its longer exposure, was evidently a composite photograph, combining effects observed at different times into something that could not have been seen at any one time.

These apparent complications may be interpreted as illustrated in Figure 1 (which is drawn approximately to scale). Let *B* represent the brighter star, and *F* the fainter companion. The Earth is supposed to be in the plane of the page, at a great distance below. *F* may be drawn as revolving around *B* in a circular orbit *O*. (In fact, both *B* and *F* describe orbits about their common center of gravity, keeping on opposite sides of it; but to put this into the diagram would complicate it needlessly.) As *F* moves along this orbit, it will hide more and more of *B*, till, finally, when its center reaches the point F_1, the eclipse will become total, and continue so till its center is at F_2.

Now suppose that *B* is surrounded by a gaseous ring of very low density (containing hydrogen and small quantities of metals, and emitting bright lines) which is rotating rapidly about it in the same direction as the orbital motion of *F*. After the total eclipse of the luminous body *B* has begun, the part of the ring at R_1 will still be visible. It is receding from the Earth, and the bright lines which it emits will be shifted toward the red. Toward the end of totality R_1 will be hidden by *F*, while the opposite side of the ring at R_2 will be visible, and give bright lines shifted toward the violet. Since both bright components disappear for about 30 minutes at mid-eclipse, the outer diameter of *R* must be considerably smaller than that of *F*.

This explanation is as simple geometrically as it is convincing. The question remains how this gaseous envelope can exist permanently in such rapid motion. It is not carried around by the rotation of the star below it, for the lines in the spectrum of this star are fairly sharp, and show that its own rotation, though doubtless in the same direction, must be much slower.

It seems probable that the gases of the ring are in orbital motion about star *B*—held up by the centrifugal force of their own motion, just as a solid satellite would be, and high enough above the star's surface to avoid friction with its atmosphere. Rough calculations show that an orbital velocity of 350 kilometers per second should be expected in this region if the mass of the bright star was about 1½ times the Sun's, and that of the fainter ones about one third as great. These are plausible enough values—though rather smaller than one might expect.

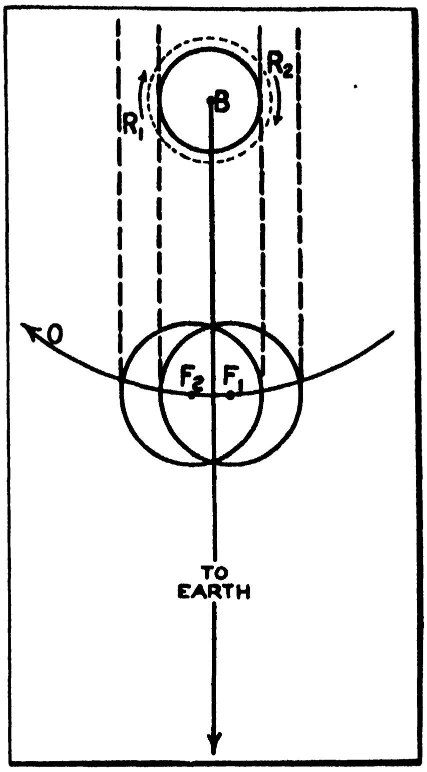


Figure 1: See the text

When enough observations of this remarkable star have been secured, the masses of the components may be found, and the equilibrium of the ring studied more fully.

How such a mass of gas "got that way" is a problem which is best left alone till we know more about the details than we do now.

Whether other stars have similar rings revolving about them is unknown. The possibility of such a thing was suggested by Struve, some years ago, from consideration of certain stars with peculiar emission lines, bright enough to be observable though the star itself is unobscured. The present ring, however, is so faint that it would hardly be observable if the eclipsing companion were not unusually faint, and it may be hard to detect other cases.

It is remarkable that two stars of such different brightness should be so close to one another. A large number of similar cases—though less extreme—are found in the lists of eclipsing variables. Indeed, such pairs have been called "typical Algol systems."

It is practically certain, however, that such systems are not typical of the short-period double stars in general—such as are detected in great numbers as spectroscopic binaries. There is no more striking example of the power of observational selection—forced upon us, independent of our intentions, by the very nature of the case.

The great majority of variable stars have been discovered by comparing photographs of the same region taken at different times. In such a search, large variations in brightness are practically sure to be picked up, while smaller ones may be missed. Under what circumstances can a large variation—reducing the normal brightness to one sixth or less—be produced by an eclipse? At the middle of eclipse we see the light of the star which is in front of the other, and often an uneclipsed part of the light of the other. Hence, to meet the condition just imposed, the eclipsing star cannot have more than one sixth of the total light of the pair, or one fifth that of its companion. Deep eclipses can come only from pairs of unequal brightness. Even among these they cannot happen if the fainter star is much smaller in size than the other; for then, if it is squarely in front of its neighbor, it will cut off only a moderate fraction of its light. When the fainter component is the larger, it may completely obscure the light of its companion, and there is no geometrical limit to the depth of the eclipse. The fact that no eclipses of a depth as great as five magnitudes have yet been observed indicates that cases in which the larger star has as little as 1 percent of the brightness of the smaller ones must indeed be exceedingly rare.

The large, faint components of these pairs are "sub-giants"—brighter than normal main-sequence stars of the same temperature, but fainter than ordinary red giants. Their masses, when known, are smaller than those of ordinary stars of the same luminosity. Their constitution presents an interesting theoretical problem which has not yet been solved.

—Princeton University Observatory, April 29, 1942.

A Maya Temple Grows Up

Archeologists in Guatemala Reveal the Evidences of a Five-Times-Reconstructed Temple

LINTON SATTERTHWAITE, JR.
Assistant Curator, American Section,
The University Museum, Philadelphia

Modern archeology is the business of digging into ruins and rubbish piles of forgotten peoples. Any archeologist will tell you he is trying to reconstruct the history of the people concerned. Some will claim that they are helping to discover laws governing the rise and decline of human societies. I believe this may be so, but that scientific curiosity is the immediate force which drives diggers to plan and sweat, and institutions and public-minded citizens to foot the very considerable bills. You, yourself, are reading this article because you are curious to know about the illustrations that accompany it.

These illustrations — the drawings on the opposite page — are reconstructions on paper of a single Maya temple and the various alterations to which it was submitted. It was part of a religious center or "city," now called Piedras Negras, in the semi-tropical forested part of Guatemala, Central America. Its ruins cover a square mile and have been extensively excavated by the University Museum of the University of Pennsylvania. I had charge of several seasons of work on the city, work which was begun by Dr. J. Alden Mason, Curator. Investigating this particular structure was part of my task, and I was assisted by William S. Godfrey, Jr., who made the drawings.

There are five isometric perspective drawings, showing how the temple was changed from time to time. The photographs will give an impression of the size. The upper left-hand drawing of the five shows it at the start. Later, the Maya had cut down the walls of the building to doorway height, as shown. The same thing was done by Godfrey on paper in the case of the fourth drawing, so that the reader can see into the room. The separate drawing shows the same building, after some changes, but with the roof in place.

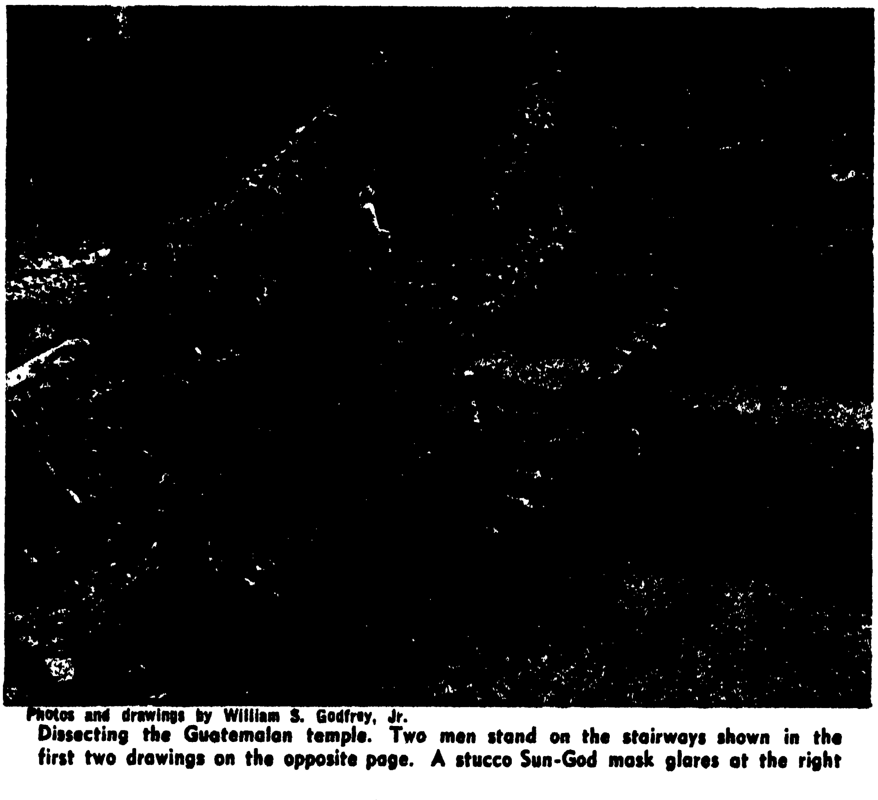
As drawing succeeds drawing, the date of the new construction shown is later and later, yet each drawing is of essentially the same thing. There was a temple building at the top; this cannot be shown in the second and third drawings because little or nothing was left of it. The building rests on a low platform, and this stands on another with a stairway, except at the time of the second drawing. Below this is a platform of either two or four terraces, with its own stairway, and this is on a terrace with yet another stairway. These platforms form an example of what have been called "Maya pyramids." They are made of solid rubble — that is, shapeless, broken rocks — which was laid up in rectangular sections. The rough platform thus built was then given a skin of plastered stone masonry. The stones in the outer walls forming this skin were laid in mortar. This is limestone country, and limestone was burned to get lime for the mortar and plaster, and, toward the end, for ornamental stucco-work. In the photographs, the plaster has peeled off.

The purpose of these bulky platforms was to elevate the temple building and the little round stone altars in it and before it. The structure provided an awe-inspiring setting for elaborate religious processions, sacrifices, and ceremonies.

The time-span of the five varieties of the temple is probably four or five hundred years. During this time the building has become smaller and more complex in design. Only in the last two periods do we find it with a fire-proof masonry roof and sculptured decoration in stone and stucco.

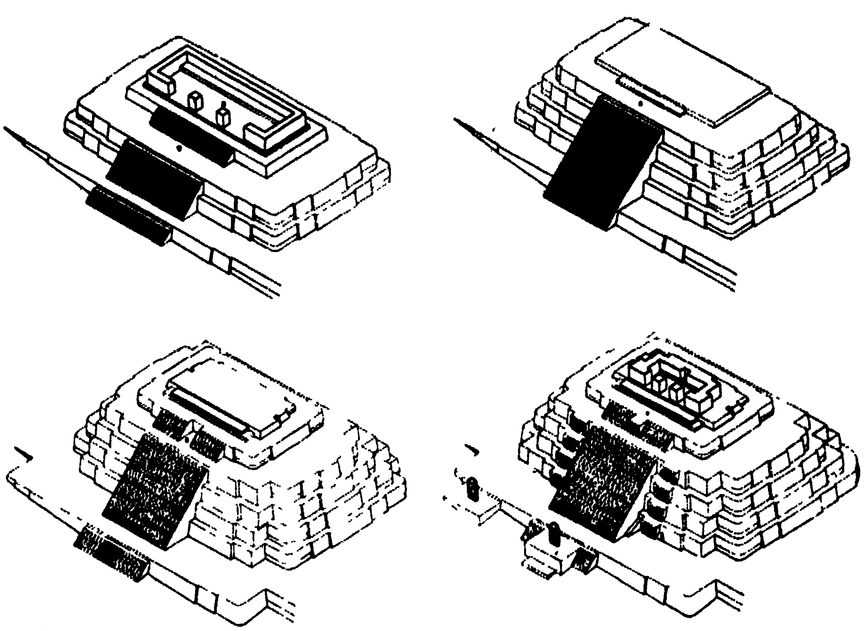
The building has been rising higher and higher and, therefore, more remote from the common people who watched the proceedings from the great court below. The rituals must have become more exclusive. In the old days of the first drawing, a good many priests could crowd into the temple and on the broad platform, and the people could probably pretty well see what was going on.

Besides this hint of changing relations between priesthood and ordinary folk, these drawings tell a story of practical considerations. The priests commanded, or the people willingly gave, an enormous amount of labor for religious building. But they did not reach their top achievements overnight. New generations, imbued



Photos and drawings by William S. Godfrey, Jr.

Dissecting the Guatemalan temple. Two men stand on the stairways shown in the first two drawings on the opposite page. A stucco Sun-God mask glares at the right

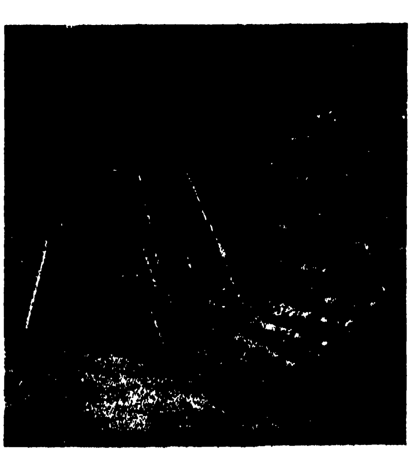


Four stages of the odd.500-year evolution of the Maya temple, as it was modified by succeeding architects who were not content to leave well enough alone

with a "bigger and better" spirit, tore down here and there. This was, perhaps, to get building stone for new works more easily. But they did not waste the labor of their ancestors by removing whole platforms. They built new ones over and around them, sometimes, as here, making use of parts of the oldest walls to the end. So they gained grander and grander effects with the least labor. The great high "pyramids" of the Middle Americans *evolved.*

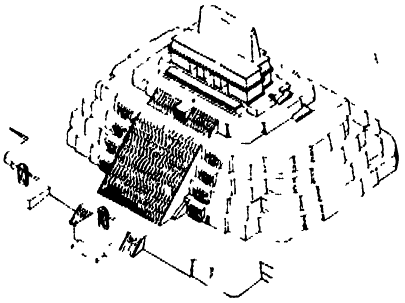
This is important to know. Many books state that the Indians were taught to carve and build by wanderers from Egypt, Asia, or from continents now submerged in the oceans; the underlying idea being that the Indian civilizations did not evolve, and that their most advanced achievements were accomplished at the start. This would be expected if they had learned all their arts from the outside. As digging progresses, however, such sequences as these at Piedras Negras show, on the contrary, more and more clearly that the Indian taught himself how to cut stone and wood with stone tools, how to burn lime, and how to build progressively more imposing settings for the worship of his gods.

Middle Americans were obsessed with an end-of-the-world idea The coming end apparently depended on the heavenly bodies. So Maya priests were astrologers, and studied the movements of the sun, moon, planets, and stars They carved extracts from their calendrical calculations on stone monuments, or stelae. Two of these are shown in position in the final two drawings; and in the photograph on the opposite page one is shown propped up on its side at the left Probably this was to help future generations of priests to improve their astronomical formulas by checking against past observations and predictions. One of the recorded dates in a full inscription was approximately that of the time it was carved and the monument set up.



A workman points to an altar hidden in a cavity behind the shoring of poles

With the hieroglyphs, scenes are often carved, apparently showing priests conducting rituals to avoid the evils indicated by the current calculations. Those at Piedras Negras are among the finest, and mark a peak in Indian sculpture That is one reason why this seemed to be a good place to dig. The carvings to be rescued, and new ones to be discovered, were of the finest; Dr. Mason saved many. In addition, here was the longest series of legibly dated monuments. This promised a maximum chance to use the Maya calendar in working out the development of their architecture.



The fifth stage of modification

We will give an example of how these carved dates can be used. Some day we shall know what the date on the central monument in the fourth and fifth figures is, in terms of our own calendar. About 675 A.D. is more than a guess, but this may be wrong. We can call it "Date X" for the present. The masonry roof on the building of the fourth drawing rests on an inverted, V-shaped, false arch, or "Maya vault." The fact that it first appears with the monument makes us fairly sure this vault was built about the time of the monument; that is, at Date X. It is one of the simplest and most easily built vaults at Piedras Negras, and therefore probably one of the earliest. Far to the east, at another site, the Carnegie Institution of Washington also has been dissecting Maya buildings. There they found a building with a vault which was erected earlier than an associated monument. The monument date is much earlier than Date X, which places that vault much earlier than ours. We have made a start toward proving that the vault was invented by another Maya group to the east. In time its use spread to Piedras Negras. Thus can an item for an outline history of Maya architecture be obtained.

A modern bomber synthesizes ideas from many sources: Explosives were invented in ancient Asia, rubber came from the American Indians, the fundamentals of radio from Europe, and the practical means of flight from white Americans. So, on a smaller scale, but in an entirely similar manner, one ancient Middle American group borrowed what it thought it could use from another, whether the borrowing involved a plant, like corn or tobacco, a deity, or a method of building construction.

The fact that, after feeding and housing themselves, these ancient Indians devoted most of their labor and genius to their gods is all to their credit, for they thought this was necessary in order to preserve their way of life for their children. Their religion, like our war, was "all-out" for the good of the tribe.

Food For Fighters

New Dehydration Process Uses Steam Baths and Heat Treatments to Reduce Vegetable Weight and Bulk

ANDREW R. BOONE

Since it is still true, during these days of high-speed tanks, jeeps, and sundry other wallop-packing vehicles, that an army travels on its stomach, Uncle Sam intends that American soldiers and sailors shall enjoy body-building and health-giving vitamin-laden vegetables along with their meat and dessert, at all distant outposts. Particularly will carrots, onions, cabbage, and potatoes be present on daily Army and Navy menus.

All vegetables contain large amounts of water, and water is heavy and bulky. Thus, when a food ship pulls into some distant outpost, bearing fresh or canned vegetables, nine tenths of the load is water, which is costly both in ship space and time to transport, and utterly without value as a food.

To avoid this wasteful practice, the army plans to feed military men in Alaska, Eritrea . . . on a score of fighting fronts . . . millions of pounds of dehydrated vegetables during coming months. When a company cook, fretting about the dinner menu, starts to prepare the evening meal, he will open two or three five-gallon tin cans, scoop out a few pounds of peas hard as baked clay and sweet corn more wrinkled than a sun-dried prune, and a half-dozen compressed cabbage disks. He'll toss the peas, corn, and cabbage into kettles of cold water. Thirty minutes later, he'll start these vegetables simmering. Another half-hour, and the vegetables will be ready—sweet, attractive, and nearly as fresh to the taste as the day they were harvested back home.

Researchers in a laboratory maintained by the United States Department of Agriculture at Los Angeles are seeing to it now that these foods will reach the fighting fronts bearing virtually all the food values of fresh vegetables. There Dr. E. A. Beavens, and others, working under direction of Dr. E. M. Chace, chairman of the department's dehydration committee, have discovered means not only of preserving the vegetables for long periods in all kinds of climate, but also of retaining virtually all the vitamins A and B, and more than half the vitamin C. Keeping vitamin C, number one scurvy preventer, which dissolves in water and just seems to evaporate from both leafy and solid vegetables between the field and home, is an achievement of the first magnitude.

Dehydrator for selecting vegetables for processing

In this "house of dehydration," Dr. Chace and his associates have solved a problem of many years' standing. Key to their taste-color-texture-vitamin preserving method is a combination steam bath and dehydration process, the latter being accomplished in a small plant containing features so new they haven't been patented yet. Here garden-fresh cabbage and carrots become brittle shells of their former selves in two hours. Two large heads of cabbage, enough to feed 20 hungry men, are compressed, after dehydration, into a disk small enough to fit in the hand. Yet, in those few ounces, there is enough cabbage to feed those same ravenous appetites.

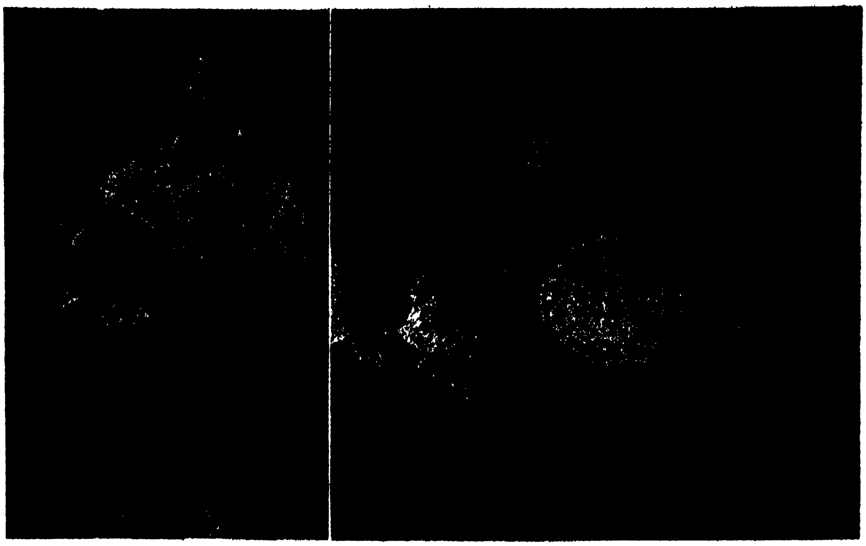
Suppose we follow the trail of a batch of carrots through the new process. We'll start with six crates, each weighing 33 pounds. They were pulled an hour ago, and now they're being topped, trimmed, washed, and scraped. Clean and crisp, just as you would serve them for dinner, they are cut into disks about a quarter-inch thick. After being spread evenly on wire trays, they are placed in a square receptacle resembling a laundry tub, and covered. For six minutes steam rises from jets below, scalding each bit thoroughly. This process is called blanching, and it performs the important task of inactivating the enzymes, organic catalysts which cause chemical transformations in plants, thereby halting processes which ordinarily would destroy the color, flavor, and vitamins.

From the steam bath, the carrots are carried to the nearby dehydrator. This device, built undersize for experimental purposes, resembles a medium-size, all-metal automobile trailer standing on rigid legs. It is not intended to dry large quantities of vegetables, but, as Dr. Beavens explained, makes possible the selection of the varieties which will yield the best dried products. Within, after the doors are closed, air flows along baffles of a newly developed pattern, passing in parallel lanes over the material. Flowing at high velocity, from 900 to 1100 linear feet a minute, with the temperature carefully regulated in the 150 to 180 degree range, the dehydrator will turn out the dried food in periods ranging from an hour, for spinach and other greens, to four hours for corn.

But back to the carrots. The contents of six crates require several runs. So we wait, and at last we have a small pile of crinkly disks. We weigh them. Seventeen pounds. They fill two five-gallon cans. Were they intended for army use somewhere across the world, the shipper would drop a small chunk of dry ice into each can before filling it. He would seal the lid tightly with shellac. The dry ice, turning to gaseous carbon dioxide, would halt any oxidization, preserving the contents of the can for a year or longer. And the two cans would occupy about one-ninth the space now required for six cases of fresh or frozen carrots on that heavily laden transport.

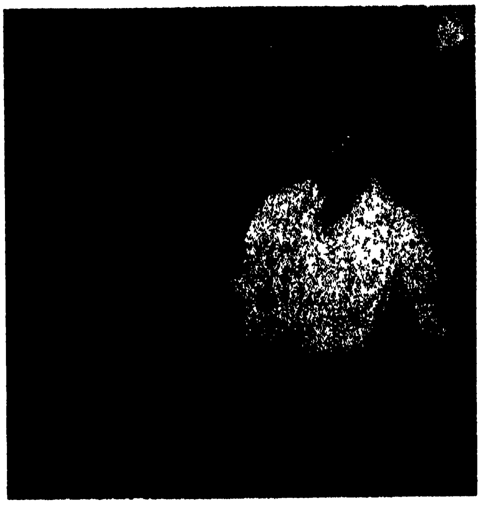
Our fighting men are due for more surprises, now hatching in this laboratory. While the war department is mainly interested in carrots, onions, cabbage, and white potatoes, Dr. Beavens is hard at work on sweet potatoes, string beans, lima beans, peas, chard, mustard and other greens. He faces three "musts" before the army will accept his results. The vegetables must keep well in all climates for at least a year, they must rehydrate within an hour, and 92 percent of the moisture from potatoes and from 95 to 97 percent moisture must be removed from all other vegetables.

Speaking of spuds, Dr. Beavens has already achieved a dish that will delight fighting men yearning for steak and French fries. He's going to give them shoestring potatoes. They'll look like dried string when they tumble from the can, but a brief soaking and quick frying will restore their firmness. Even "canned willie" will taste like T-bone when accompanied by this delectable morsel.


Cabbage before and after dehydration. Two heads (four pounds) shrink to a six-ounce disk. Disk is compressed from shredded leaves (at right) after dehydration

Seven firms produced 7,000,000 pounds of dehydrated vegetables last year. Then the British began asking for dehydrated tomatoes, and inquiring about dehydrated carrots. Arizona carrots got a big boost recently when Margaret C. Smith, University of Arizona chemist, reported the copper state's product contains from three to ten times more carotene, source of vitamin A, than other carrots.

"Carrots," reported an R.A.F. officer, "ought to give our fliers cats' eyes by preventing night blindness." Walt Disney drew up three sketches showing carrots winging their way through the sky. Copies, wired from Hollywood to London. are posted in all R.A.F. barracks, urging pilots and bombardiers to eat carrots in all available forms. As a result of inquiries, from fighting forces both at home and abroad, production is zooming. It is estimated 25,000,000 dehydrated pounds of all vegetables will be produced during 1942—enough to provide 300 servings for 1,000,000 soldiers.


Steaming (blanching) at 212 degrees, Fahrenheit, precedes dehydration of carrots

Civilians will get to know these foods better, too, as time goes on and transportation facilities take on heavier defense loads. Although most popular now in the nation's markets is a little package containing a scoop of chicken fat, some noodles, and pieces of dehydrated vegetables, which becomes a quart of noodle soup after the addition of water and a few minutes' boiling, you can also get several other soup-making mixtures and such individual items as potato shreds, onion flakes, carrot cuts, pea and bean powders, tomato pieces and flakes, and spinach and celery flakes. In each case, all you need do is add water, heat, and eat. They'll increase in weight from eight to 40 times their dry weight as they take up water. But all the food essentials are there, just as in canned and fresh vegetables.

Don't let the word "dehydration" fool you into thinking you'll get tough, stringy, hard-shelled beans and carrots and peas and corn, when these vegetables are prepared by the modern method. True, dehydration means that nine tenths or more of the water is removed. Processes developed in the last few months do that, and more. After you rehydrate the vegetables in your kitchen and simmer them a half-hour, they're practically as good as garden-fresh vegetables.

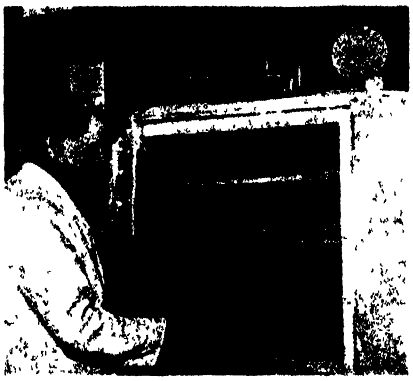
The other afternoon I carried home from the Los Angeles laboratory four samples: A scant handful each of dehydrated corn, small lima beans, and mixed peas and carrots. They had been dehydrated in the new apparatus nearly two months earlier. The beans were almost hard as rocks; the corn, shrunken to a fourth its natural size, brittle and sugary; the peas and carrots only apparent shells of their former selves.

That evening, the samples were soaked a half-hour in cold water, then simmered a half-hour. When fully done, we had enough to feed eight people. All four vegetables had returned to their normal shapes and sizes, the peas had their accustomed green sheen and the corn looked as if it had just been cut from the cob. Except for a stray kernel and an occasional pea, all were sweet and juicy. Had I not seen them before cooking, I would not have known them from fresh.

We stay-at-homes know little of the dietary deficiencies which soldiers suffer when they go without fresh fruit and vegetables for a long time. One of the dread diseases faced by fighting men on some distant desert or arctic base, should their supply lines be cut, is scurvy. As early as the Civil War, semi-dehydrated vegetables were fed Union troops, but they were unpleasant to the taste, and possessed no antiscorbutic properties. Again, during World War I, both the Germans and Americans used dried vegetables. Many doughboys fighting in France will remember dumping his ration on the ground to avoid eating them, but these vegetables were entirely different from those which are now being made available.

Once tasteless and lacking in nutrition, dehydrated vegetables now provide both food and medicines. In a wide-scale California experiment, nutritionists and chemists for Anabolic Food Products, Inc., are feeding 20,000 acres of parsley, turnip greens, and beets special diets to increase their tissue-building values, and possibly to add a little extra zip in the form of vitamin C. The diets are prescribed after analyses of the soil and water indicate what plant foods are deficient.

Formerly potash, phosphorous, and nitrogen were thought to be the essential food elements for growing plants. Now, in addition to the Big Three, the dehydrators are turning their attention to the so-called trace elements such as boron, manganese, sulfur, calcium, iron, and phosphorous. Dr. J. W. Wigelsworth is cultivating super-vegetables, and already has turned out strains of leafy plants containing three times the average amount of iron.



Removing carrots from dehydrator

When these dehydrated vegetables reach far-flung American military and naval fronts, soldiers and sailors alike may be sure they're getting more iron in their parsley, added bone-building calcium in their turnip greens, extra manganese in their beet greens, and abundant copper in the green sprigs of parsley.

Army chiefs know soldiers will complain, no matter how tasty the chow. But they're making sure the steamed and dried carrots and peas, and all their kin, will return to their original form, size, and appearance; cook tender; and give off nearly all the odor and flavor of the fresh article. They may be bone dry at 11 o'clock. But when the chow bell rings at high noon, they will be "garden fresh."

In fact, recent tests at the University of California showed dehydrated peas, string beans, carrots, and spinach to be actually superior in color, after cooking, to the canned product.

When it comes to shipping, as has been pointed out, great savings will be effected. One pound of dehydrated pumpkin contains 12 times more fuel value than a pound of fresh pumpkin. Not only does a ton of fresh cabbage yield 215 pounds of the dehydrated product, but the fuel value of the dried leaves actually equals 2279 pounds of cabbage freshly boiled in the kitchen. One cargo ship will do the work of 16 when it comes to hauling tomatoes, because this vitamin-rich vegetable loses 93 percent of its weight when dehydrated.

Those are some of the reasons why Uncle Sam is so interested in food during this war, and they explain how he is planning to carry more bullets and bombs to distant places without cutting into food rations on the firing line.

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HALLUCINATION

You Can Be Trained To "Hear Things"

Perfectly normal persons can be taught to "hear things" where there is no sound. Details of how such hallucinations can be produced by the simple form of learning known to psychologists as "conditioning" have been reported by Prof. Douglas G. Ellson, of the University of Mississippi.

Nearly half of a group of subjects taking part in Prof. Ellson's experiment under the most favorable conditions, learned to hear a tone when it was not being sounded. They had been prepared to "hear" it by a learning period during which the tone was sounded regularly every 30 seconds for 30 repetitions.

When the actual sounding of the tone was introduced and ended gradually, the subjects tended to have the hallucination of a tone after it had ceased to sound. If the start and termination were abrupt, however, only a few (8.5 percent) developed the hallucination.—*Science Service.*

POISON IVY

Infection Prevented by Protective Ointment

An improved protective ointment against poison ivy has been developed and proved effective by the United States Public Health Service. The new ointment, made with either of two bases, will remain effective for several weeks if kept in a closed container.

The ointment should be thickly applied to exposed parts before contact with poison ivy. Clothes must be removed after exposure before the ointment is washed off, otherwise the unprotected skin may be exposed to clothes which have been contaminated. Tools and instruments or clothing which have been used in cutting poison ivy must be decontaminated before being used again. Decontamination can be effected by washing clothes or immersing tools for 15 to 20 minutes in a 1 percent solution of calcium hypochlorite.

The two formulas were developed by Drs. Louis Schwartz, John E. Dunn, and F. H. Goldman of the Public Health Service:

Formula 1

Castor oil	21.5%
Olive oil	21.5%
Lanolin, anhydrous	21.5%
Diglycol stearate	12.9%
Paraffin, refined	8.6%
Boric acid	2.0%
Sodium perborate	10.0%
Duponol WA pure	2.0%

Formula 2

Cetyl alcohol	35.1%
Stearyl alcohol	5.3%
Ceresin	3.5%
Castor oil	20.8%
Mineral oil	21.9%
Duponol WA pure	1.7%
Sodium perborate	10.0%
Boric acid	1.7%

IN THE BRAIN

Sex Perverts Found Not Lacking in Hormone

Dramatic transformation of seven "somewhat effeminate," jealous, jittery young men into he-men with beards, an interest in girls, and enough ambition to advance in their professions or to get off relief rolls into regular jobs was recently reported by Dr. Jacob Kasanin, director of psychiatry at Mount Zion Hospital, San Francisco, and Major Gerson R. Biskind, Letterman General Hospital, San Francisco.

These young men had undeveloped male sex glands, but had not "become sexually depraved in the sense of becoming interested in homosexuality," the physicians reported. Treatment with the male sex hormone, testosterone, by implanting "banks" of the hormone in their muscles to supply the deficient amount from their glands, brought about the personality changes reported.

A group of patients examined on account of homosexuality, on the other hand, did not show any evidence of lack of sex hormone secretion. "This points to the fact," the physicians conclude, "that homosexuality and sexual perversions are probably psychological in origin."—*Science Service.*

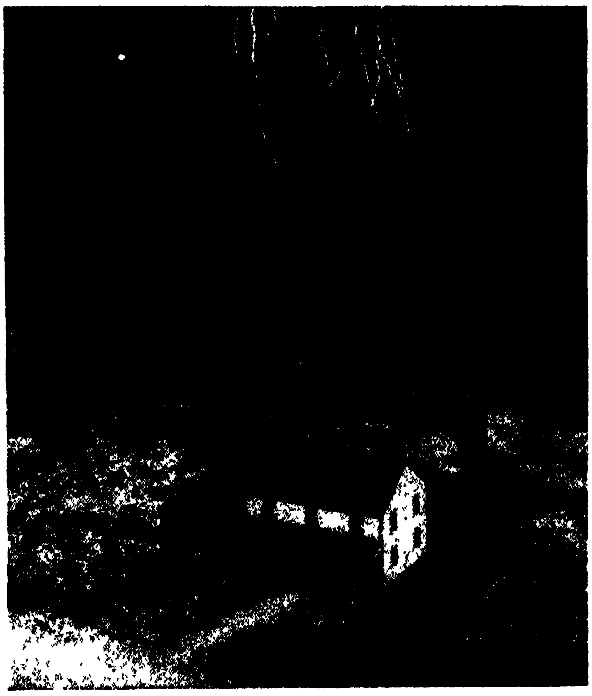
When Lightning Strikes

Applied Research Has Reduced Greatly the Damage Done by Natural Lightning, Yet Much Study is Still Ahead

Dr. GILBERT D. McCANN
Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

Each year about 16 million thunderstorms occur on the earth, causing an average of about 50 lightning strokes to the earth each second, or a total of about two billion strokes a year, which are a potential source of destruction. If these strokes were equally distributed, about eight strokes a year would strike each square mile of the earth's surface.

In the United States alone lightning strokes cause about 400 of the annual 92,000 accidental deaths, about the same number as street-car or airplane accidents. They produce some $12,000,000 worth of damage to farm buildings, 55 percent of all oil-tank fires, and untold damage to forests through fires. Lightning constitutes a serious hazard to aircraft, munitions dumps, and explosive manufacturing processes. It is a hazard and a source of interference to both telephone and radio communication. Electric power systems, however, constitute by far the greatest potential targets for lightning destruction. The extensive character of transmission lines and distribution systems contributes to their being struck frequently by lightning, and maintenance of continuous service and prevention of damage to equipment places stringent requirements on lightning-protection devices of various types.



A model house protected from artificial lightning by lightning rods. Although the rods were struck many times, neither house nor nearby trees were hit

There are today in the United States about 83,000 miles of high-voltage transmission lines transmitting large blocks of power from our 42 million kilowatts of generating machines to many load centers. Lightning is by far the most serious cause of trouble on these lines. Aside from the serious damage it can cause to electrical equipment, the loss of service it can produce not only results in considerable inconvenience to power consumers but also may produce damage and result in the loss of many hours of operation for certain types of manufacturing processes for which even a momentary loss of power is serious. Maintenance of continuous service is particularly important in these times of national emergency.

Studies of the number of times transmission lines are struck by lightning reveal that in the eastern part of the United States a mile of line is struck, on the average, about once a year. Thus, a 100-mile line would be struck 100 times. Storm density, of course, varies throughout the country, but it is estimated that the 83,000 miles of transmission lines are struck at least 60,000 times a year.

Twenty-five years ago knowledge of lightning and the protection of power systems was so limited that every time a line was struck at least a service interruption occurred. Today, through knowledge gained by lightning research, a 100-mile line can be protected so that it does not have an outage more than once every four or five years, instead of 100 times a year.

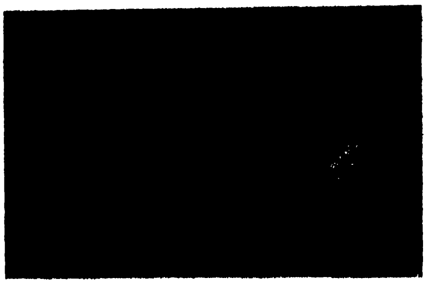
In addition to high-voltage transmission lines, many thousands of miles of distribution circuits feeding individual consumers in both rural and urban areas must be protected from direct strokes and from induced voltages produced by a lightning stroke in the vicinity of the line. The electric fields associated with a stroke may produce dangerous voltages on such circuits.

Through co-operation of the public utilities and electrical manufacturers, and through the use of special recording instruments, such as the Klydonograph, cathode-ray oscillograph, surge-crest ammeter, Boys camera, and the Fulchronograph, valuable information has been obtained regarding the mechanism of the stroke discharge and the voltages and currents associated with lightning. Also of great importance have been the data obtained by the United States Weather Bureau on the variance of storm density throughout the country.

This knowledge has led to the use of ground wires and vertical grounded masts located over and around transmission lines and substations to intercept lightning strokes and conduct their high currents harmlessly to earth, thus preventing lightning from directly striking live conductors carrying power. Their principle is similar to that of lightning rods on buildings. Contrary to a common belief, lightning rods, properly applied, provide effective protection. This misconception has largely been due to the fact that a great many applications in the past have been faulty and ineffective. This type of protection has also been found applicable to oil tanks, munitions dumps, or any object that can be damaged by a direct lightning stroke.

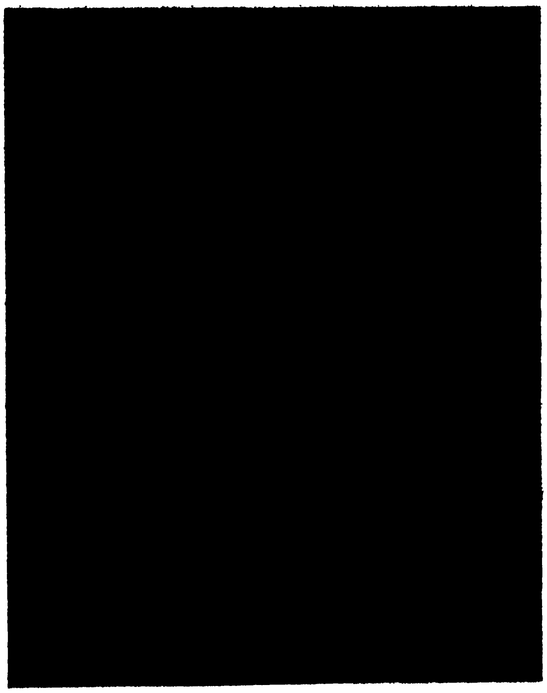
Voltage-limiting protective devices such as lightning arresters have been so perfected that they effectively limit voltages produced by lightning on power systems to magnitudes which will not damage equipment. They are also used effectively for protection of radio transmitters and telephone equipment. The Bell Telephone Company has so developed lightning protection of its systems that loss of service rarely occurs and it is quite safe to use the telephone during thunder storms.

It has been found possible to duplicate many of the important properties of lightning in the laboratory and thus study the performance of protective devices. The voltages and currents associated with lightning are of extremely high magnitude—millions of volts and hundreds of thousands of amperes — but they are frequently only a few hundred-millionths of a second in duration. However, it has been found possible to duplicate and measure them. It is possible also to reproduce the essential characteristics of the stroke discharge from cloud to ground in model laboratory sparks and thus study with model transmission lines, substations, and the like, the performance of shielding ground wires and vertical masts.



When the air, a low-value conductor of electricity, can no longer withstand the electrical stress of the field of a thunder cloud, lightning strikes and the electrical balance between earth and air is restored

It is important to measure and study the electric and magnetic fields produced by lightning strokes. These are the source of "static" interference in radio reception, a type of interference which also bothers telephone circuits. These fields are so intense and of such high frequency that they can induce dangerous voltages not only on power and telephone circuits but also in certain manufacturing processes using explosive materials. A spark caused by a flashover from such an induced voltage is a potential source of explosion or fire. This is a problem which has become more important with the expansion of our war industries. The most effective way to eliminate this hazard is to shield the building or area in which the explosive process is taking place with a conducting shield or "Faraday cage" which completely surrounds it. This prevents the penetration of the electrical field produced by a lightning stroke.



Artificial lightning strikes the models

Lightning is a hazard to all types of aircraft. Captive balloons attached to conductive cables are likely to be struck during a thunderstorm, and airplanes are sometimes struck by being in the path of a stroke to ground while flying below a thundercloud or by precipitating a cloud-to-cloud discharge while flying in the thundercloud itself. Aircraft can become electrically charged while passing through a thundercloud, and when they land they may be discharged by a spark which can be hazardous. This is particularly true of seaplanes making forced landings, as they often lighten their load by dumping gasoline.

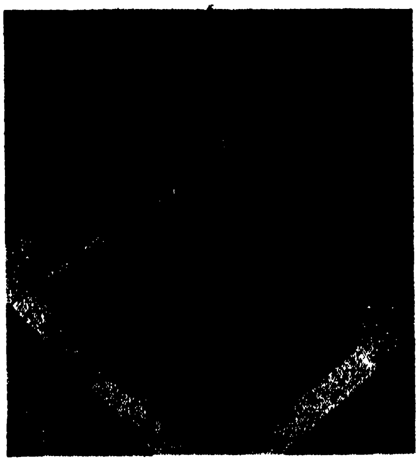
For the solution of such problems a knowledge is required of the fundamental processes involved in the formation of charge in the thundercloud. The energy of this charge formation is supplied by highly turbulent upward air currents, which are essential to the formation of the cloud itself. This turbulent condition in the cloud is also important as a hazard to aircraft. It also is essential to the formation of precipitation. Thus, the electrical properties of a thunderstorm are closely associated with all of its other properties and for this reason of much concern to meteorologists.

Building a miniature transmission line for studying lightning effects

The thunderstorm plays an important and fundamental role in the natural state of the earth. Although it is not commonly realized, the earth, besides being a magnetic body, is also electrically charged. We are all familiar with the fact that there are magnetic fields produced by magnetic materials concentrated mainly at the North and South Poles. However, there is also at all times a negative electric charge distributed over the surface of the earth and a positive charge in the outer regions of the earth's atmosphere. These two sets of charges produce an electric field in the air directed vertically toward the earth.

During fair weather this field is about 30 volts per foot at the earth's surface. Measurements of the charge density on the earth indicate that the total charge on it is at all times about 500,000 coulombs. Owing to a certain degree of conductivity of the air in the form of free ions, the air has a low conductivity and the presence of the electric field produces a leakage current from the earth, tending to discharge the earth's negative charge. If it were not for some restoring agent the earth would be completely discharged in five or six minutes by this leakage current. Lightning plays the fundamental role of returning this charge back to the earth and maintaining it in its normal charged condition. Thus, there exists a continuous cyclic process of discharging and recharging the earth. The key to this process is the ionization of the earth's atmosphere which makes possible its conductance and the leakage current. This ionization also plays a role in the formation of the charge in the thunder cloud and the breakdown of the air which produces the spark discharge of the stroke to earth. This ionization is produced by three sources:

1. Alpha, beta, and gamma rays (or X-rays) emanating from radioactive minerals in the earth's crust. 2. Radioactive gases in the atmosphere, which are products of decomposition of radioactive minerals in the earth. 3. Cosmic rays emanating from the outer universe.


This motor-driven wheel, carrying many small steel strips on its periphery, measures lightning. When lightning strikes, a small coil magnetizes each strip as it passes a given point. By later measuring the magnetism of each strip, a fairly complete picture of the lightning stroke can be drawn for further careful study

Lightning is not altogether destructive. It is also a beneficial agent to plant life, for it produces in the air large quantities of nitrous acid which are carried into the soil by rain. It is estimated that the 16 million storms that occur annually produce about 100 million tons of this fertilizing agent. This gigantic amount exceeds by far the total output of the nitrogen-producing industry.

As a result of the concentrated efforts of the various research organizations that have been studying lightning and the electrification of thunderstorms, great strides have been made in the past 25 years and many of lightning's properties have been well established. Also, many of the problems of protecting against its destructive effects have been overcome. However, there are still important properties of lightning about which more knowledge is needed, and although considerable progress has been made, many questions still remain for further investigation.

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BLACKOUTOLOGY

Why Red Light Is Better than Blue

Eyes have two-way vision—one set of sense organs (the cones) for daylight seeing and the other (the rods) for darkness. Both operate at the same time only when the light is about as bright as full moonlight. Differences between the eye as a night-vision instrument and the daylight eye, important for night warfare and blackouts, recently were described by Prof. Selig Hecht, of the Laboratory of Biophysics, Columbia University.

Night eyes are thousands of times more sensitive than are day eyes. The night pilot who has been flying in the dark for an hour or more could see the light of a candle 12 miles away even if it were exposed only for a thousandth of a second. If it burned continuously, he could see it over 200 miles away, were it not for interference of fog and haze at night, or for smoke and the curvature of the earth For this reason it is dangerous in a blackout to use a flashlight, or light a match or even a cigarette in an open space. The flame of a match can be seen by a pilot many miles away.

On the other hand, night eyes cannot see as *sharply* as day eyes. When it is necessary to recognize small forms and slight differences in shade and shape, you must have good lighting and use your daylight eyes. You need your day eyes to read an instrument or your watch.

But the brightness of different colors is not the same when you see them at night as when you see them in the daytime. This is particularly important when you want to use colored lights to see best during a blackout without giving aid to the enemy. Blue and green are easiest to see. Red and orange, which seem so conspicuous in the day, are hardest to see at night.

Nothing could be more dangerous than the use of blue lights during blackouts, Prof. Hecht declared. "For reasons which are none too clear at present, the notion has gained prevalence that blue lights should be used to illuminate objects, and that these would furnish less light to distant aviators because blue is supposed to be a dim light. Indeed, the Germans and the English, and at the beginning we ourselves, used blue lights during blackouts."

When we need a light during a blackout—to watch a dial, read a compass or a road sign—we must use our day vision for this purpose. The enemy aviator, however, needs only his night vision in order to spot that light.

Your night eyes and your day eyes happen to be equally sensitive to red light. If you see the light at all, you can also see it with your color-sensitive day eyes and you have the day vision's advantages of ability to recognize shapes.

But, for blue light, your night vision is 1000 times more sensitive than is your day vision. In other words, if you have enough blue light so that you can see a road sign, the light will be 1000 times as bright to the night-seeing pilot as would be a red light of equal effectiveness.—*Science Service.*

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WOOD FARMING—**Mississippi farmers now are planting millions of pine seedlings provided by the Masonite Corporation, manufacturers of hardboard and insulation board products. The new industrial demand for pine wood has given cash-crop value to land previously considered worthless in the South.**

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TEST FOR pH

Made Quickly With Simple Equipment

Control tests for pH (degree of acidity or alkalinity of solutions) can now be made rapidly by unskilled workmen with simple equipment. Also, quick preliminary tests can be made in laboratories where more elaborate pH apparatus is available.

The simple technique of pH testing using the Cargille Buffer Set depends upon the use of 17 buffer tablets which, when dissolved as directed, provide 17 solutions of known pH value.

These solutions, applied to a strip of test paper, bring out a specific color on the paper for the pH value of the solution used. Thus, when making tests, a drop of the solution to be checked is placed on the test paper and the resulting color is compared with the chart furnished with the paper. A solution of known pH value, close to the pH value indicated by the first test, is then placed on the test paper beside the sample. By proceeding in this manner until differences in color are scarcely perceptible, the pH value of a sample can be quickly judged to about 0.5 pH unit.

Checking color produced on test strip by sample and by solution of known pH gives quick determination of pH of the sample

It is claimed that color comparisons made in this manner are more accurate than those which are made with a color chart alone.

JAP NYLON

May Enter World Markets—After the War

Japanese industrial chemists are already preparing for an industrial struggle to follow cessation of the shooting war. This is the conclusion that may be drawn from three articles published in Japanese, in the *Journal of the Chemical Society of Japan,* during 1940 and 1941. The author, K. Hosino, research man for the Oriental Rayon Company, Ltd., tells how he analyzed nylon, the synthetic plastic fiber that has made the United States independent of silk. After he had determined how the molecules were put together, he duplicated them and then made modifications which he claims are improvements over the American product.

This procedure, reminiscent of prewar tales of how Japanese mechanics would build a duplicate of any machine that Occidental manufacturers would sell to their employers, might give Japanese textile factories the means to compete to great advantage with nylon mills in this country and Europe. Japan has persistently refused to enter into any patent treaty with any foreign country, so that the du Ponts, originators of nylon and owners of basic patents thereon, will have no protection against Japanese attacks on their business, especially in the export market.

Nylon, the Japanese chemist states as a result of his analysis, is a "polyamide of hexamethylenediamine combined with adipic acid."

If Japan goes into the nylon business, the silk industry, already hard hit first by rayon and then by the cessation of American silk purchases even before the outbreak of war, may never come to full revival. It is reported that hundreds of thousands of mulberry trees have already been felled in Japan, to make room for more food-crop production. Quite possibly these groves may never be replanted. Silk may again become what it was in the Middle Ages and early modern times—a luxury for the rich.

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PROTECTION — Tiny robot sentries — new secret devices built into miles of high wire fences enclosing some of the nation's great war production plants—are said to be saboteur-proof by du Pont engineers who developed the system. The acoustic fence "overhears" birds chirping, the snip of a wire-cutter, the scrape of a shovel, even whispers, relaying these sounds to a central control room from whence a squad car rushes to the precise point of disturbance.

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SALT ROADS

Wear Better, Resist Frost

The practice of using rock salt in the subsurface of roads, which originated in Nova Scotia as a means of protecting roads against extreme winter conditions, is spreading in this country with remarkable results reported. First employed to keep frost from heaving the road surface, salt has been found to do more than serve as an anti-freeze. Through a simple action it also stabilizes the soil used in the subgrade so that the road bed is firmer, giving longer life to the wearing surface.

One of the most interesting examples of subsurface treatment with salt is found in Cayuga County, New York. The first salt road in Cayuga County was built in 1936, and in succeeding years additional salt roads have been laid down. According to Gail Ball, County Superintendent of Highways, none of these roads show any sign of frost damage.

"Employing a system that we have used successfully ever since," he said, "we first used the salt not in the subsurface but in the original surface. We were convinced that salt worked into the surface would give us a longer-wearing road and we put down about eight tons of rock salt to the mile, raking and rolling it in. After two years, in which the salt-surfaced road held up excellently, we gave it a light sprinkling of salt, and then put on a macadam surface. Although other untreated roads nearby have suffered severely from frost since that time, this road has shown no frost damage whatever. We feel that we are getting extra value from the salt in this matter of frost-heave prevention, since that was not our primary purpose in using it."

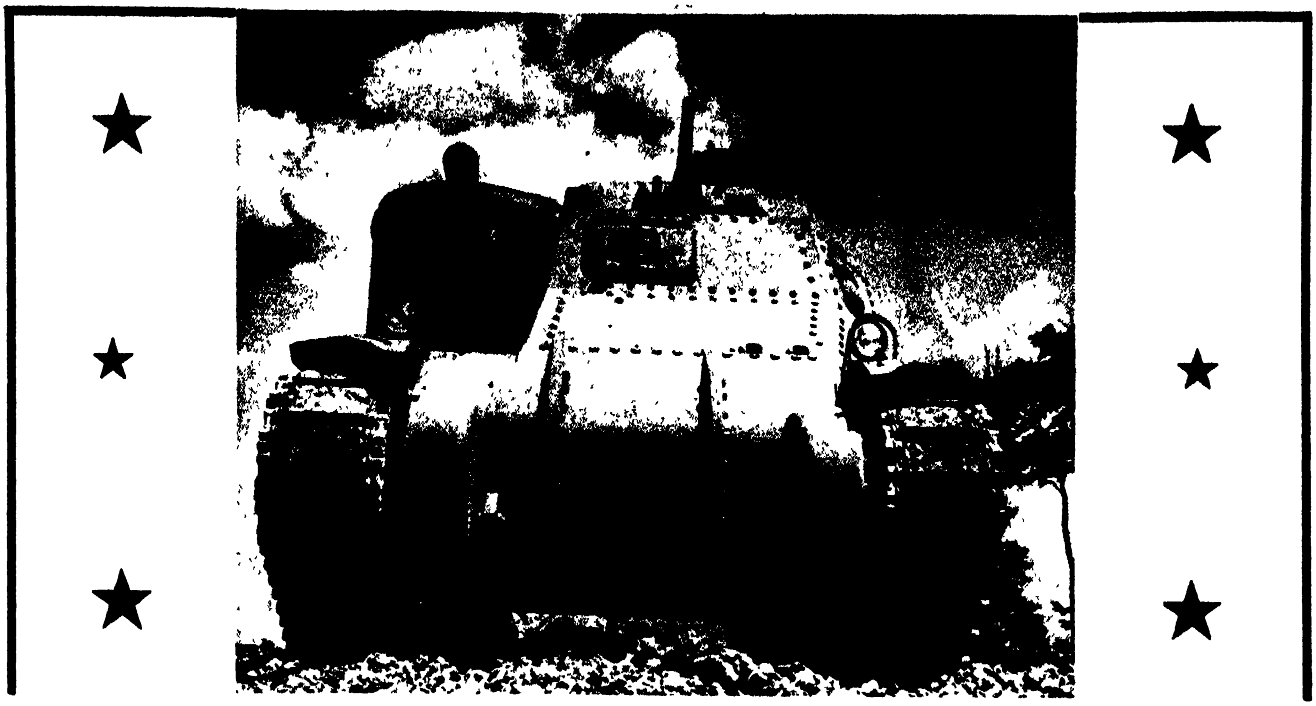
EMPLOYEE DESIGNED

Work Simplification Program Aids Production Drive

An assembly fixture, designed in his spare time by Albert Wender, an employee, and manufactured out of scrap materials, has raised the output of siphon tubes for Army tank fire extinguishers from 100 to 400 parts per eight-hour shift at the New Jersey plants of Walter Kidde & Company. John Space, another employee, has worked out another scrap steel device that increased the output of valves for gas-type airplane fire extinguishers by 25 percent. Gains of 71 and 100 percent in other typical assembly operations have resulted from this showing of employee inventiveness.

These are the tangible results of the Work Simplification Program that is playing a major part in the war production drive. This program, which was inaugurated two months ago, is itself the invention of a Kidde employee—B. P. Corcoran, who until recently was a worker on the assembly line. Night school courses acquainted Mr. Corcoran with the principles of motion study, and his years of ex-

John Space and his scrap-made unit



Men in the Armed Forces — Soldiers, Sailors, Marines — Would Appreciate a Gift Subscription to Scientific American

As a gesture to those hundreds of thousands of American men who have severed their home and business ties to do their part in building up the Army, Navy and Marine Corps of the United States, Scientific American is making a special offer of half-rate subscriptions when mailed to members of our armed forces.

Keep the boys informed of the happenings in Science and Industry which are so important to our present-day economy, and which will be doubly important to them when they return to civilian life. Send us the names and addresses of those members of the services to which you want the magazine sent, enclosing only $2 for each one (regular subscription price is $4 a year) and we will mail Scientific American regularly to each one of them for a period of 12 months.

There is a constant call for reading matter from all branches of the service. Here is your chance to make life a little happier, a little fuller, for the boys by sending them the one magazine that gives them accurate and authentic information on progress in a wide range of fields. Just fill in the coupon below (use a separate sheet if you need more room) and send it to us with the correct remittance. We will do the rest.

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perience as a worker gave him the idea of applying these principles to the men themselves.

The basis of work simplification is the fact that the man on the job often knows more about improving that particular job than a highly trained engineer. The basic problem is how to bring out these ideas and the two major difficulties are expression and shop psychology.

Under the Work Simplification Plan, the workmen work out their own ideas and present them as accomplished facts. The starting point is the foreman or group leader. Regular classes are held for these men in which they are acquainted with the principles of motion study, expressed in simple shop language rather than engineering terms. In these classes they are given assistance in working out their own ideas, and prepared to help the men under them.

In addition, a machine shop, completely equipped with hand and power tools, has been provided for the employees so they can develop their own devices. Employees can use this shop either on their own or on company time, and a skilled machinist is always present to aid the worker with an idea.

CORRECTION

In "From The Ground Up" Article

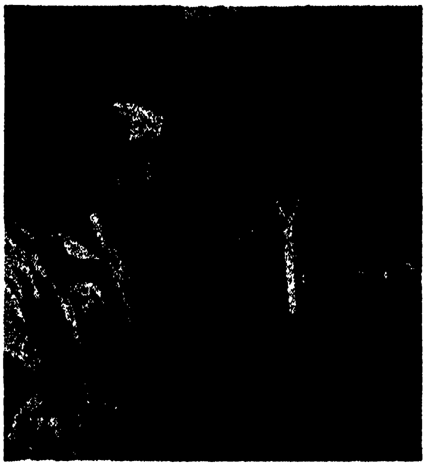
Several of our readers have called our attention to discrepancies which appeared in the article "From the Ground Up," by Douglas M. Considine, which appeared in our June 1942 issue. In the last paragraph of the second column on page 279 of the article, continued to the top of the third column, production of TNT should be read in pounds instead of tons. The same correction should be applied to the discussion of picric acid and smokeless powder, in the same paragraph. It appears that this error crept into the final typescript during transcription from the original.

MILK PROTECTION

Ultra-Violet Rays Kill Bacteria

A new U-shaped Sterilamp, using beneficial ultra-violet rays, may be the future means of keeping milk fresh for many hours longer, in addition to providing completely sterile bottles. Designed primarily for use in dairies, this new development of the Westinghouse Sterilamp may easily be adapted in other bottling operations such as soft drink manufacture, canning factories, and pharmaceutical concerns.

Highly efficient methods of washing milk bottles now employed by modern dairies may be improved upon by use of the Sterilamp, it is reported. At the present time, bottles returned to the dairy are put through a process of warm and hot water solutions. After that, the bottle is washed with germ-killing chemicals. At this particular point, the bottle is sterile, but it must be rinsed. Most city water used for that purpose has been proved to have considerable bacteria, and although harmless in most cases, they cause milk, if left standing, to turn sour.



U-shaped Sterilamp in laboratory

The ultra-violet rays of the Sterilamp will correct this. After the bottle has been washed, it will pass along the conveyor belt to a battery of Sterilamps, one of which will be inserted in each bottle for a period of ten seconds, the time required to kill all bacteria. Then the milk will be poured into it immediately and a sealed cap will insure its purity.

ELECTRONIC GADGETEERING

May Replace "Hams'" Interest in Communication

From now on we shall see a rapid development of electronic gadgeteering—the non-radio application of radio technique—according to Charley Golenpaul, of the Aerovox Corporation.

"I believe the era of electronic gadgeteering is now opening up in a big way," states Mr. Golenpaul. "In the first place, the ban on amateur radio communications is not going to leave the enterprising 'ham' twirling his thumbs. Of course many 'hams' are already or will soon be in our armed and technical services. Many will find wartime jobs with other United Nations. But those remaining on the home front are going to put their experience, equipment, and ambition to work on new and startling applications in the home, shop, factory, and elsewhere, far removed from customary radio practice.

"I suppose most radio men have heretofore been too busy with radio proper to find extra time and energy for non-radio or electronic gadgeteering possibilities. However, many of them now are going to use their 'rigs' and parts for new functions. I can visualize some interesting developments — light-beam telephones for conversing over considerable distances; automatic photo-electric garage-door openers; photo-electric switches turning lights on and off with darkness or daylight; checking the stoking of furnaces or boilers by the chimney smoke; various comparators or instruments for comparing and matching colors and shades; checking solution concentrations and chemical studies by conductivity means; and so on.

"As a starter, electronic gadgeteering can be based on well-known elementary principles and basic circuits long known to radio and electrical workers. Many industrial plants are already electronic-gadget conscious. I know of radio servicemen who've gotten themselves good jobs in plants because of their ability to do things better, quicker, and less expensively by electronic means.

"Make no mistake about it, the temporary suspension of 'ham' communications may well turn out to be a boost. It will generate a lively interest in electronic gadgeteering. And when 'ham' communications are resumed again with the return of peace, I venture to predict that electronic gadgeteering will comprise a greater field for radio parts, particularly the quality or extra-heavy-duty components, than all amateur radio activities put together. Furthermore, many a 'ham' will find an interesting way of making real money out of his hobby, and that's something."

CELLULAR RUBBER

Is Light in Weight, Used in Life Rafts

New lifesaving devices, made of the newly-discovered cellular rubber, which has twice the buoyancy of cork, include a raft composed of a spider-like network of disks of the new material strung together with ropes, and self-lighting electric lamps which will float in the water beside victims of a sinking ship to guide rescuers at night.

Because of the extreme lightness of the cellular rubber, which is composed of millions of small cells filled with nitrogen gas, the raft will support up to 30 persons, according to the United States Rubber Company. An advantage of its construction is the ease with which it may be grasped in the water. It is of particular significance in torpedo sinking because it can be thrown overboard when there is not time to launch a regular lifeboat or raft.

The new form of hard cellular rubber is also being used as insulation under decks of mosquito type torpedo boats, and the soft material in life jackets for the United States Engineers. Also, a fire resistant, hard cellular rubber is being used as supports of self-sealing gas tanks in airplanes.

SABOTAGE PREVENTION

Aided by Electron Tube Equipment

The use of electron tube equipment for detection of intruders has become a major factor in protecting property from sabotage, according to a recent issue of *Electronics*. One company alone, it is stated, has installed 4100 photo-electric alarms, of which 1300 are operating outdoors Capacity systems protecting safes and acoustic systems guarding vaults electronically are too numerous to estimate.

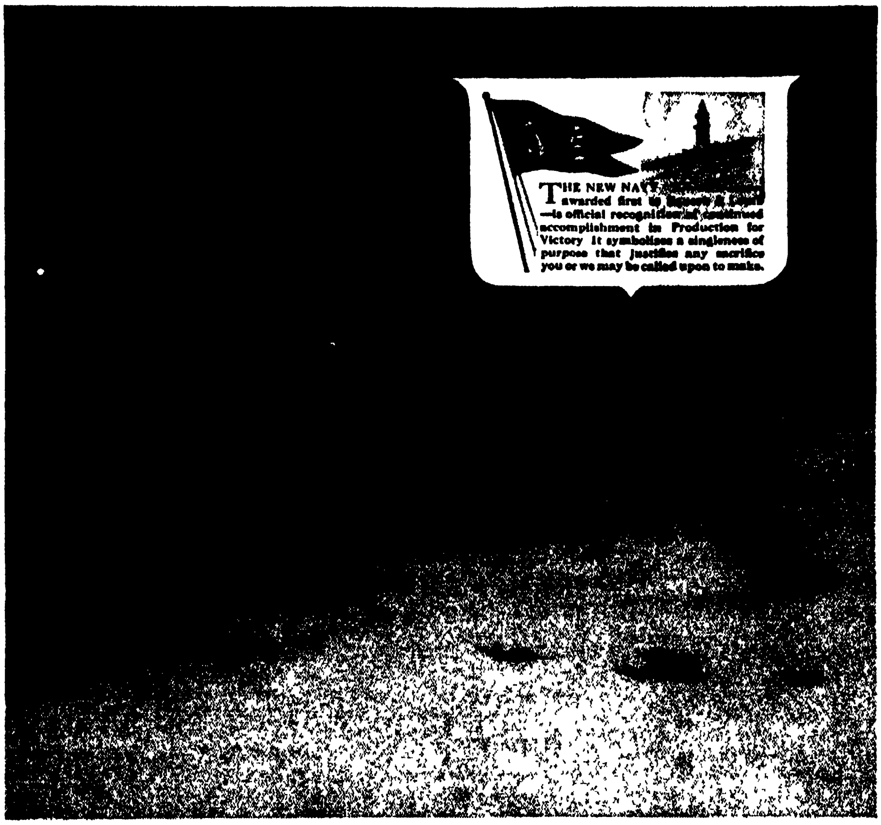
Electronic intrusion-detectors may operate "local" signals, ringing bells, blowing horns or whistles and turning on floodlights. They may also actuate "proprietary" system signals, calling guards from somewhere within the protected premises to the threatened point, or they may operate remote signals in "central station" offices maintained elsewhere by firms specializing in the installation, operation, and maintenance of protective systems.

For many years industrial, mercantile, and residential premises have been protected against burglary by electrical alarm devices supplementing the work of guards. Such electrical systems have now been joined by electronic intrusion-detection devices. These are proving useful where supplemental protection is desired, where series wiring cannot readily be installed and where alarms must signal at the approach of an intruder rather than after an attack upon premises or fixtures begins.

Photo-electric intrusion-detectors substitute a beam of light for older methods of protective wiring using foil pasted over windows or show cases housing valuable objects. Here, interruption of the beam projected from light source to light detector actuates a local or remote signal.

Sharply-focused lenses, hoods, and masks, plus "modulated" light beams, simultaneously make it difficult for intruders to paralyze photo-electric alarm systems by shining the beam from a flashlight into a phototube and walking through while the relay is held in the stand-by position. Light-beams are very nearly invisible even in smoky or dusty air as most projectors now contain optical filters confining emission largely to the infrared region. Mirrors are generally used indoors to break beams up into curtains of light criss-crossing the area to be protected. Three or four reflections are commonplace and as many as a dozen have been successfully used.

Weather-proof cases and carefully chosen components which continue to function properly despite wide variations in temperature and humidity permit systems of the type described to function outdoors. Useful beam-throws of as much as 500 feet have been achieved by mounting projector and detector units on heavy pipes embedded in concrete blocks sunk into the ground to maintain alignment. Where extremely long beam-throws are required, duplicate projectors and detectors rather than mirrors are advisable for turning of property boundary corners. Because of other advantages inherent in design, such equipment is useful for indoor as well as outdoor applications where somewhat


THE NEW NAVY [illegible] awarded first to Bausch & Lomb —is official recognition of continued accomplishment in Production for Victory It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make.

Confidence Rides With The Dawn Patrol

WHEN the bombers of the Atlantic Patrol thunder into the dawn, their pilots look ahead with confidence—confidence born of faith in their machines and the fuel that drives their motors. American fuels, like American planes, are built to bring back safely those who fly.

Somewhere, in an American refinery, one of America's great army of behind-the-scenes workers, with a Bausch & Lomb Refractometer, is doing his part in making American oils and gasolines so efficient and safely dependable. Modern refractometric methods of control speed refining operations and maintain a greater uniformity and higher quality than ever achieved before.

Here, again, optical science — with Bausch & Lomb instruments — is at work helping to strengthen America's front lines. Today, American manufacturers—like the nation's armed forces — turn to precision optical methods for critical analysis, precise measurement, quality control. Bausch & Lomb Contour Projectors, Metallographic Equipment and microscopes for inspection and control take their place alongside range finders, gun sights and binoculars in contributing to the vital needs of national war effort.

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greater cost appears justified by the additional protection afforded.

One unusual installation has guarded a waterfront stretch of nearly 3000 feet for more than five years, transmitting few false-alarms despite dense harbor fogs. A special projector unit using an 18-inch lens and an airplane beaconlamp (to widen beam-spread and avoid operation of the alarm by sea-gulls) was built for this job and the projector unit as well as the detector unit floats in comparatively calm tidal water off the end of a dock. Its purpose is to detect intrusion from the sea side of the property. Standard projector and receiver units have since been designed for such marine application.

• • •

SUN FOR HENS—Modern poultry farm hens now bask for several hours a day under portable sunlamps developed specially for animals. The new sunlamps, source of Vitamin D, eliminate the daily doses of cod-liver oil usually fed to chickens but now threatened by war shortages.

• • •

IT STRETCHES

Synthetic Rubber Thread For Military Uses

What is believed to be the first synthetic rubber thread ever developed in this country has been made from Ameripol synthetic rubber. In announcing the development, W. S. Richardson, of The B. F. Goodrich Company, said:

"Primarily this development has been for military purposes, to conserve the natural rubber thread that formerly went into products used by our armed services. There is at present no possibility that any of the thread can be diverted to the manufacture of civilian products, but we hope that future circumstances will allow that course."

Some of the potential military uses for the synthetic rubber thread are in harnesses for parachutes, in gas masks and respirators, and in other equipment.

As now planned, the thread will be sold to textile manufacturers for military purposes in either the "naked" or uncovered form, or covered with yarn by the rubber manufacturer. "Naked" rubber thread is later covered in the textile mills. Cotton is the textile fiber most commonly used, although rayon, nylon, and silk are also employed.

Rigorous tests on the new synthetic rubber thread show 700 percent elongation, comparable to the rubber thread previously made from natural rubber compounds. Its comeback, or "kick" is comparatively the same, while its physical properties, under accelerated aging, are better.

The thread resists the effects of dyeing or bleaching much more than the natural rubber products, resists the action of body oils carried in perspiration much better, and has greater resistance to chafing or cutting by the needles of the knitting machines. It is non-toxic and made only in black.

Synthetic rubber thread has been developed, for military use only

• • •

NYLON—A new du Pont nylon plant in Virginia, which started production in November, 1941, will be spinning by mid-summer a million miles of nylon yarn—per day!

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SOYBEANS

Face a Bright Immediate Future

China's great contribution to America's victory farming, the soybean, will receive greater attention than ever during the coming crop season, according to G. G. McIlroy, director of the American Soybean Association, reports *Science Service*. Nine million acres, 54 percent more than last year, are expected to be planted to this versatile crop, which can contribute feed for the production of meat and milk, oil for explosives, paint, soap, and human food, or can be plowed under to give the soil the nitrogen which diversion of nitrates into munitions is taking out of commercial fertilizers.

Needs for handling this unprecedented soybean crop are stressed by Mr. McIlroy. We must have, first of all, available acreage. There must also be adequate machinery for cultivating, harvesting, and processing. There must be ample storage space for the beans, and for oil and cake after pressing. And finally, proper markets for oil and meal. The market for oil and meal need give no concern, at least for the duration. We are going to need all the oil for food and industrial uses that we can produce, not only as long as the war lasts but through the period of dearth that will inevitably follow it. And the same will doubtless be true for meat and milk.

FORESTS SPRAYED

To Protect Trees on Basis of their Value

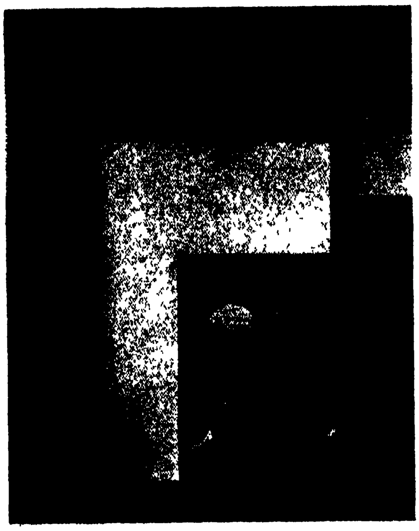
Spraying of woodland areas has developed into something of a "big business" with a scientific background. Modern high-pressure spraying machinery and other equipment has been evolved to meet the necessity, the United States Department of Agriculture reports. This technique now has wide application in all parts of the country.

The adaptability of the autogiro for applying arsenicals over forested areas has been demonstrated and this type of equipment bids fair in time to completely supplant the use of ground machinery, say the forest entomologists. It may lower the cost of the application of insecticides to such a figure that it will be economical to protect forest lands from insect depradations on the basis of the value of the threatened timber stand rather than on the additional threat of spread to and destruction of forests in other areas.

WALL PANELS

In Colors, To be Cemented in Place

Plastic coated wall panels which are completely pre-finished and require no "on-the-job" treatment after installation are a development urged to speed up emergency housing con-



Three types of new wall paneling

struction and remodeling. Supplied in sheets as large as four by eight feet, the pre-finished boards are a product of Barclay Manufacturing Company.

Designed for either new structures or for speedy modernizing by covering old walls and ceilings, the sheets are best applied by a water-proof adhesive, but may also be installed with brads. They are available in 10 colors which are permanently bonded to the sheets by heat treatment. The surface is water-proof, stain-proof, dirt proof, vermin proof, and may be cleaned with soap and water.

Available in three types—Tileboard, Panelboard, and Streamlined Board—the sheets may be installed by any competent carpenter. Besides the more obvious applications in bathrooms and kitchens, the plastic-coated panels are also recommended for playrooms, nurseries, closets, laundries, service stations, barber and beauty shops, meat markets, bakeries, restaurants, hospitals, boats, and trailers.

● ● ●

VEHICLES—The rise of the motor vehicle as an instrument of government is revealed in figures of the United States Public Roads Administration, which show that while private motor vehicle ownership in the United States has risen 20 percent in the past decade, the number of vehicles owned and operated by federal, state, and local governments has risen 146 percent.

● ● ●

SUGAR BEETS

Improved Seed, New Labor-Saving Devices

Two tedious hand processes have kept sugar-beet growers dependent on field workers. Nature's generosity in packing each beet seed with the germs of several plants has meant hours of back-breaking labor down the long rows, thinning the clumps of new beets by hand until those remaining could have space to grow and be healthy. Right now, when we need it most, comes "singled" seed. A machine developed at the University of California breaks the beet seed into segments, each containing the germ of but one plant. Planters are easily adapted for sowing the singled seed, and the small number of multiple plants can be chopped out by hoe or cultivator. One farmer cut his thinning costs in half last year by using singled seed. The seed itself is more expensive, but only one third as much, by weight, need be planted.

The second laborious hand process is the harvesting. A Colorado farmer has been tinkering for years, trying to evolve a machine for lifting beets

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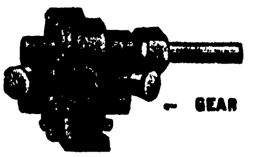

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No. 1 Centrifugal	¼"	⅛"	$ 6.50	$25.00
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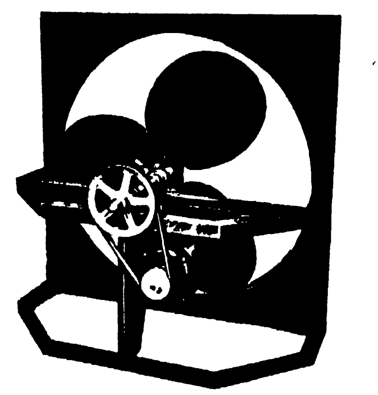

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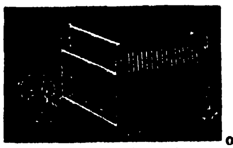

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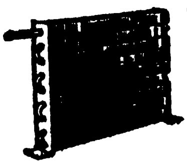

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10"	1500	550	13.50
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16"	1750	1800	21.00
16"	1140	1650	27.50
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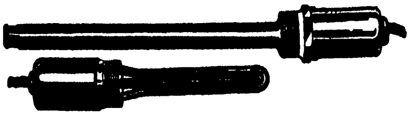

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0½	⅛	1750	350	6½"	3¾"	25 00
1	1/5	1750	535	6 "	4½"	30 00
1¼	¼	1750	950	7½"	6 "	37 50
1½	½	1750	1900	9½"	7 "	75.00

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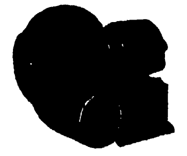

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out of the ground and topping them. He has achieved it at last and a farm-implement manufacturer has refined his crude design. Now a machine marches down the rows where before men stooped and pulled, shook the dirt from the fibrous roots, cut off the tops, and stooped and pulled the next. Another single-row topper-lifter has been developed at the University of California, and in that state of vast farming operations there are already several multiple-row machines in use.

These thinning and harvesting problems pre-suppose good seeds. Again the timing has been right. Government agricultural experts have long been at work improving the seed strains, so that now the yield is better by three tons per acre than formerly. Resistance to the curly-top disease that menaced all beets west of the Rockies, where nearly one third of the nation's crop is grown, has been successfully developed also.

The sugar beet growers have been called upon to produce well over one third of the 5,300,000 tons of sugar which Leon Henderson has designated for civilian use during 1942. Anticipated contributions from other sources are: 500,000 tons from Southern cane, 600,000 from Hawaii, 1,100,000 tons from Puerto Rico, and an equal amount from Cuba and others. Our Allies and war materials will get the remainder of Cuba's output.

OIL PROOF

Aprons and Gloves Find Many Uses

DEVELOPED expressly to prevent dermatitis, folliculitis, and other occupational skin diseases prevalent in many industries is a new line of oil-proof and solvent-proof gloves and aprons recently announced by Resistoflex Corporation. The gloves and aprons are made of an extremely tough, flexible material with high resistance to tearing and abrasion, and the aprons are supplied in both a transparent type and a heavy-duty type employing a flexible fabric coated on both sides with a sturdy film of the same material.

According to the manufacturer, these gloves and aprons are immune to all organic solvents, including aliphatic, aromatic, and chlorinated hydrocarbons, and even to that highly active inorganic solvent, carbon disulfide. The gloves are said to be successfully used in dry-cleaning and degreasing operations where protection is needed against carbon tetrachloride, trichlorethylene, perchlorethylene, benzol, or petroleum solvents, and in magnaflux operations where they are

Protection for work and worker

unaffected by kerosene, varsol, and so on. Because the gloves contain no sulfur, they do not tarnish highly polished metal surfaces and are recommended for inspection of ball bearings, aircraft parts, and the like.

Although the gloves are not as pliable as rubber or synthetic rubber gloves, they are sufficiently flexible to afford unrestricted movement of the fingers, and because of their immunity to the above mentioned solvents they do not require repeated washing with soap and water.

• • •

SPEED—Close teamwork between American steel makers and truck and plane transportation recently enabled a British factory manufacturing tank bearings to receive a shipment of especially treated steel within four days. The steel ingots were made in the midwest and rolled into rods which were then shipped overnight by express truck to a wire-drawing concern in New England and drawn into wire. A second express truck then rushed the wire to another manufacturing plant for heat treating to specification. A plane then rushed the wire to the English plant ahead of schedule.

• • •

INSULATION

For Buildings Offers

New Cotton Use

About 25 times as much cotton insulation will be used this year as last—12 million pounds compared with half a million pounds—the United States Department of Agriculture estimates. The Agricultural Marketing Administration says that the new insulating material will go into defense housing and other buildings and into refrigerator cars, trucks, and other transportation outlets. In 1941 the Department actively promoted demonstrations of the new cotton insulation, and the increase in demand is regarded as a result of satisfactory experience in the early test.

This new building material offers one promising outlet for part of the anticipated large carryover of lower grade short-staple cotton. High grade long-staple cotton is urgently needed for military purposes, and cotton farmers have been asked to plant plenty. But, as Secretary Wickard recently pointed out, an estimated three fifths of the cotton now produced is short staple, that is, one inch and shorter. Some of this is used for coarse fabrics, but much of it would be more serviceable in cotton insulation.

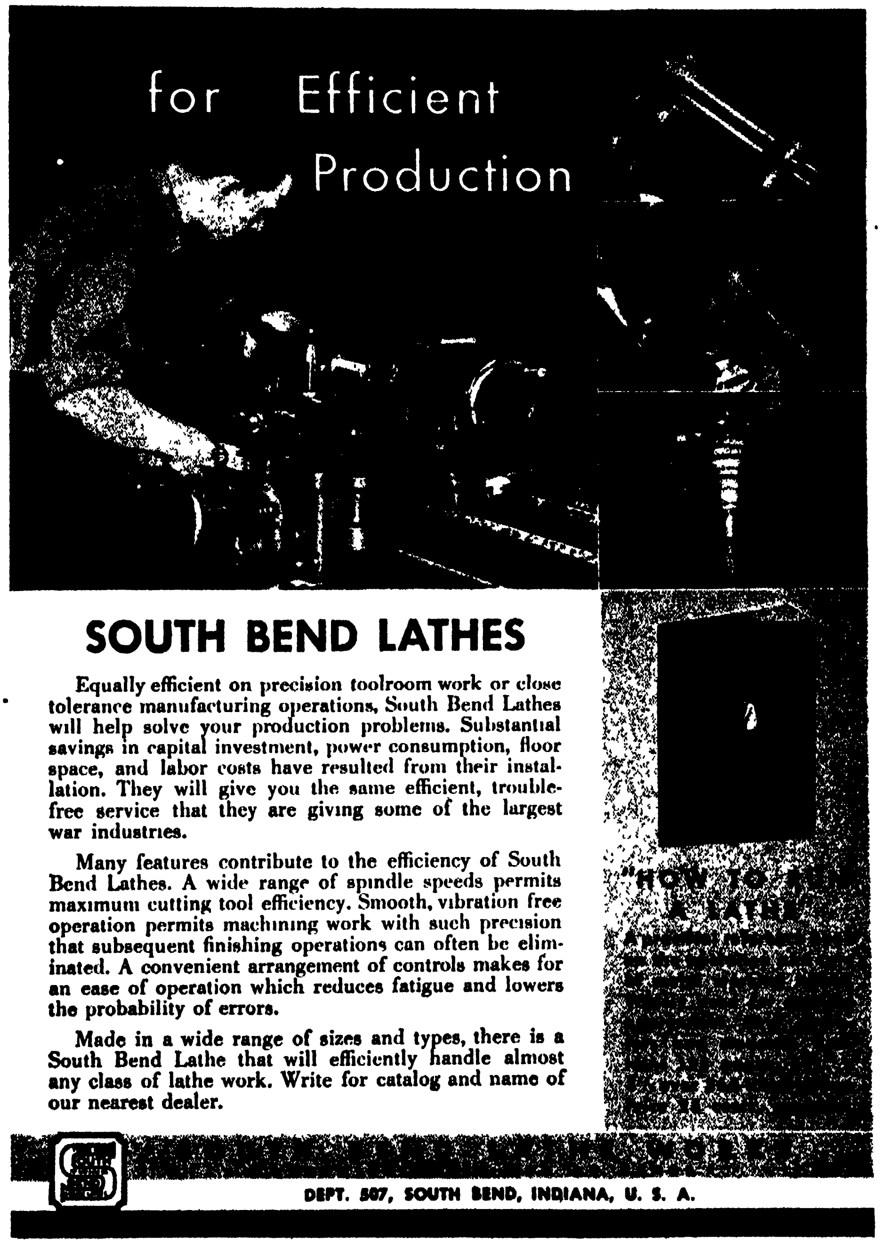
Use of cotton insulation, says the Agricultural Marketing Administration, is not restricted by priorities, and much of it is already going into defense housing. Private individuals who are building or improving homes are not barred from using cotton insulation. It is easily installed in new houses at the time of building. It is applicable to existing dwellings in accessible parts, such as under the roof in attics, or in unplastered side walls.

CULVERTS

Of Wood, To

Replace Metal

An all wood culvert, designed by The American Rolling Mill Company, is now in production and serves as one solution to the problem of building drainage structures without the use of critical materials. On war projects, where steel is required for engineering reasons, sufficiently high priorities are granted to fill the request. However, on many drainage



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Many features contribute to the efficiency of South Bend Lathes. A wide range of spindle speeds permits maximum cutting tool efficiency. Smooth, vibration free operation permits machining work with such precision that subsequent finishing operations can often be eliminated. A convenient arrangement of controls makes for an ease of operation which reduces fatigue and lowers the probability of errors.

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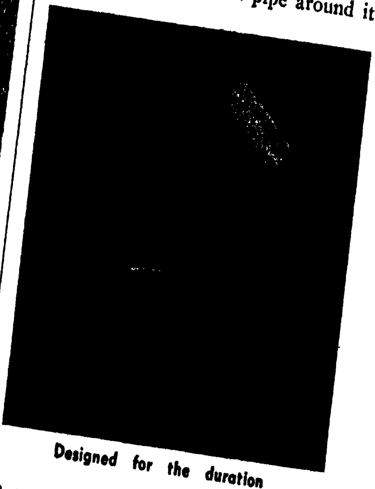
BOOKLET ON REQUEST

THE WALDORF-ASTORIA

PARK AVENUE · 49TH TO 50TH · NEW YORK

operations there is a definite need for substitutes. For such purposes the wood culvert was developed.

In the case of army camps and cantonments, the wood culvert will serve the expected life of the projects. Where the culvert is used in a permanent installation, post-war replacement can readily be made either by threading a conventional corrugated metal pipe through the wood culvert, or by packing a metal pipe around it.



Designed for the duration

But replacement with steel is for the tomorrow of peacetime. Right now the wood culvert is filling the need of the present.

Because the culvert's construction employs very short lengths of wood, sizes which ordinarily would be discarded may be used to make the wooden drainage product. The only field work required is to join standard sections into any desired length, and skilled labor is not needed. Prefabricated, the culvert is light, easy to handle and to transport and assemble at the scene of operations.

• • •

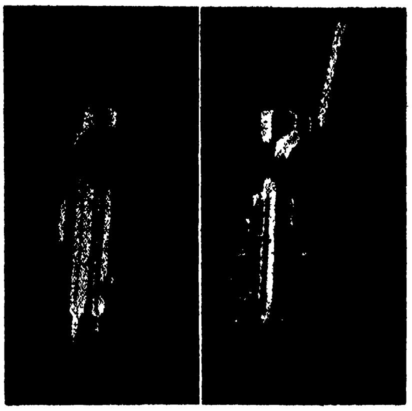
VITAMINS—*Variance in Vitamin A content of each shark liver is due to several factors—grounds where the sharks have been feeding, grounds where they are caught, the season of the year. Also, male sharks have a much higher vitamin content than female.*

• • •

FLASH-RULE

Combination Has Many Uses

A handy combination of flashlight and six-foot steel rule, illustrated in one of our photographs, was originally developed by Giffords, Inc., for use by fuel-oil delivery men who must measure oil tank levels in dark cellars. The combination had been found adaptable to other uses as well and



Light, tape measure, sling

hence has been made available for general distribution to the public.

Another feature of the combination is that the steel tape can be pulled out and slipped into a slot at the pointed end of the flashlight, thus forming a loop or sling by means of which the flashlight can be suspended around the neck, hung from the shoulder, or hooked around a pipe or beam to direct light conveniently.

QUICK-DRYING

Paints Produced from Domestic Materials

Two new oils have been developed which will make it possible for the paint industry to continue the manufacture of quick-drying paints and varnishes. With imports of tung oil cut off by war in the Far East, the industry, it was feared, would soon be forced to return to the manufacture of slow-drying paints. The new developments, however, will make such a move unnecessary. It is even felt that they may permanently replace China-wood oil in this country.

Developed by Spencer Kelloff & Sons, the new oils are known as Kellin and Kellsoy Basically they are made from linseed oil and soybean oil to which quick, hard-drying qualities have been imparted by a secret process. Commercial production is getting under way, and the company plans to increase output substantially.

Most of the principal raw materials, flaxseed and soybeans, are grown in large quantities in this country. More than 50 percent of all the flaxseed used in this country is domestically grown, with the balance imported from Argentina. All of the soybeans consumed in the United States are grown here. A satisfactory hard-drying oil has been made from castor oil by chemical reconstruction of its composition. However, the raw material, castor bean, has to be imported from Brazil.—*Chemical and Engineering News.*

Lighting Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2⅛ inch bore, 5 inch stroke, 1400 RPM, battery start ignition

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M-8	Amp Hrs	11	Ea.	2.00
L-20	Amp. Hrs	13	Ea.	2.50
L-40	Amp Hrs	25	Pr.	4 00

All cells 1 2 volts each

Above prices are per unit cell For 6 volt system use 5 cells 12 vt—10 cells, 110 vt—88 cells. Note: On all cells 75 amps or less an additional charge of 10% is to be added for trays.

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Cargo Planes of the Future

Special Equipment Will be Needed for this Branch of Air Transportation When it Starts its Growth

ALEXANDER KLEMIN

Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

SEVERAL airlines this year so far have received revenues of over half a million dollars from transportation of express and freight, and mail cargo revenues over a number of lines total several million dollars annually. Yet commercial transportation of cargo by air in the United States is still in its very early stages.

So far no really special equipment for cargo work has been available. Therefore a paper by Charles P. Graddick, of United Air Lines, presented at the Annual Meeting of the Institute of the Aeronautical Sciences, which discusses operating requirements for air cargo equipment, is very welcome.

Not only must we have special aircraft, according to Mr. Graddick, but other facilities will be required as well. For example, in some of the largest cities special cargo airports should be constructed and at most ordinary airports space should be provided for freight warehouse facilities. Warehouses will be needed for temporary storage of goods awaiting transfer from one airline to another. Space will be needed for railway express agencies and for freight forwarders. Our ordinary hangars may have to be modified to include movable platforms, storage space, hoists, derricks, tractors, and so on. The general ground handling of goods must be given far greater thought than hitherto.

What will be air cargo schedules? There will be, Mr. Graddick says, air cargo ships operating on regular transcontinental cargo schedules between large centers of population. There will also, of course, be feeder planes and feeder routes.

What will be the cost? Undoubtedly rates will be a large factor in determining the volume of air cargo. There is a limit to what shippers can and will pay for speed. At the present time, air express rates are from four to seven times rail express rates and correspondingly higher than rail freight rates. A great effort, therefore, will be necessary to reduce ton-mile operating costs of air cargo planes. This can be attained only by intense study of the airplane, which is being conducted both by United Air Lines and by Air Cargo, Inc., the instrument of all carriers.

Speed of air cargo ships will have to be great but there will also have to be low operating cost which can be attained only by somewhat lower speeds than for passenger craft and greater simplicity of construction. It may be possible to work out movable bulkheads and folding seats which would make possible changes in seating capacity and cargo space by shifting the position of the bulkhead, folding it away into the floor. Some heating will be needed and also some refrigeration will have to be provided for fresh meat products, fruits, and so on. On certain local operations, single motor planes of special cargo carrying type might be utilized. It has even been suggested that gliders might be practical for regular day-by-day all-weather operations. The glider would bear the same relationship to the airplane that the car bears to the locomotive of a train.

A decided advantage of cargo operation will be that it will provide a splendid training service. A pilot will have served as co-pilot in a cargo plane before advancing to Captain. Before a Captain on a cargo plane is transferred to passenger runs, he will be a well seasoned pilot who will have much more weather and flying experience than would have been possible had he gained' his experience merely at school.

Mr. Graddick concludes with such factors as airports, warehouses, schedules, rates, pick up and delivery service and other factors which will have to be carefully studied before our cargo picture becomes satisfactory—yet there is no doubt in his mind that such difficulties will be readily overcome.

RAIDERS

Our Navy Comments on Fighting Planes

A GREAT deal of secrecy must, of course, shroud our aircraft operations

Like the Kingfisher, whose name it bears, the OS2U preys on underwater lurkers

against the Japanese and it is only rarely that the Navy lifts the veil a little and praise is given to the factories which are producing fighting American aircraft.

Recently, however, Secretary Knox and Rear Admiral John H. Towers have informed Douglas Aircraft Company that the "Dauntless" dive bombers and the "Devastator" torpedo planes have distinguished themselves in recent raids. They also stated that in a recent engagement between Japanese land-based aircraft and Grumman "Wildcat" carrier-based fighters a total of ten Japanese fighters and three bombers were destroyed without a single loss to our fighters.

A letter to Vought-Sikorsky said that the "Kingfisher" (OS2U), a cruiser- and battleship-based observation-scout, has been very effective in combatting the submarine menace and has also made successful attacks against the enemy.

The "Kingfisher," as can be seen from our photograph, has excellent vision, owing to the liberal use of transparent plastic material. It is a trim, mid-wing mono-powered plane with an air-cooled engine. A single main float is employed which can be readily replaced by a landing gear. —*A. K.*

ICING

Another Airline Safety Problem Solved

ALTHOUGH the airlines have flown more than 287 million miles during the last three years, they are still concerned about the difficult problem of icing of the carburetor intake, and it remained for Victor J. Skoglund of the United Aircraft Corporation to carry through laboratory tests in a comprehensive research into this important problem.

Special refrigerated tunnels had to be employed and a great many runs were made with scoop and carburetor subjected to high air stream and icing conditions. One of our photographs shows an assembly of carburetor air scoop and a portion of the engine cowling as it appeared before installation in the tunnel. Another picture shows ice formation practically blocking the air induction system below the carburetor — an occurrence prevalent when moist air is cooled by fuel evaporation.

As a result of his experiments, Mr. Skoglund made radical changes in the design of the air scoop; he developed a scoop with heated air valve and also a new type of fuel discharge nozzle in which the hazard from ice formation by evaporation of fuel is eliminated. —*A. K.*

Above: Air scoop. Below: An ice-blocked carburetor intake system

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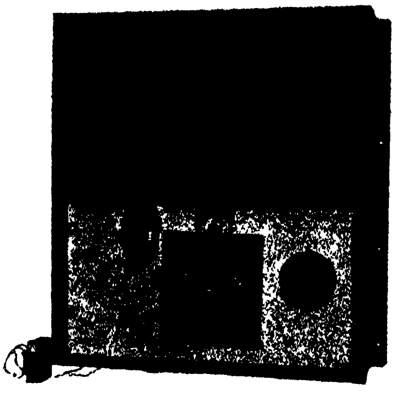

PHOTOGRAPH shows a typical coil-inspection machine, performing 11 tests on one telephone coil.

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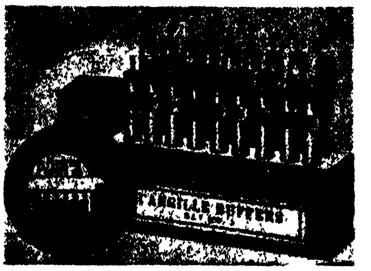
New pH Tester



Indicates These pH Values:

3.0	4.5	6.0	7.5	9.0
3.5	5.0	6.5	8.0	10.0
4.0	5.5	7.0	8.5	11.0

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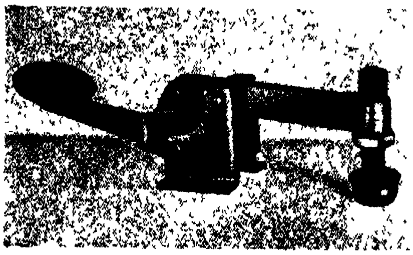
TOGGLE CLAMP

Exerts Pressure of 500 Pounds

For holding small parts when riveting, drilling, or reaming, a toggle clamp recently announced by Knu-Vise, Inc., takes the place of the many makeshift devices which are often used for these purposes.

The clamp, illustrated in one of our photographs, is screwed or bolted to a base. The screw at the holding end is then turned down to the proper adjustment for the work in hand. By pressing on the opposite end of the clamp, a holding power of 500 pounds per square inch is applied to the rubber capped screw, the clamp automatically locking in place. Unclamping is accomplished by simply lifting up on the pressure end of the lever.



Speeds up hold-down operations

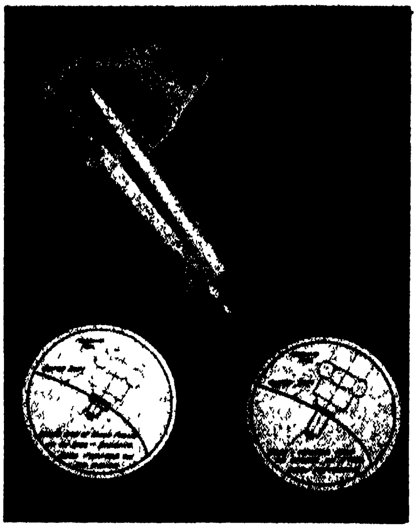
RIVET

Set Blind, Can Also Serve as Anchor

Set with a plier-type hand tool, or more rapidly with a pneumatic power tool, a new type of blind rivet, known as Rivnut, can be employed for blind rivet assembly of sheet metal or to provide a screw anchor on sheet-metal surfaces, or both.

As shown in one of our illustrations, this Rivnut, manufactured by the B. F. Goodrich Company, has a hollow shank which is threaded to provide a means for driving and also to act as a screw anchor if this is desired in the finished job.

In application, the rivet is spun on to the threaded mandrel of the applying tool. The rivet is then inserted into a hole in the sheet and the applying tool is activated. This movement pulls the mandrel of the tool back against the anvil, setting up compression in the rivet shank that causes the shank to bulge and form a ring-type head back of the sheets. The tool is then removed by backing it out of the threaded shank, the threads being unharmed in the driving operation and thus suitable for use in anchoring equipment If anchorage is not desired, the hole can be plugged by application of a headed or headless screw.

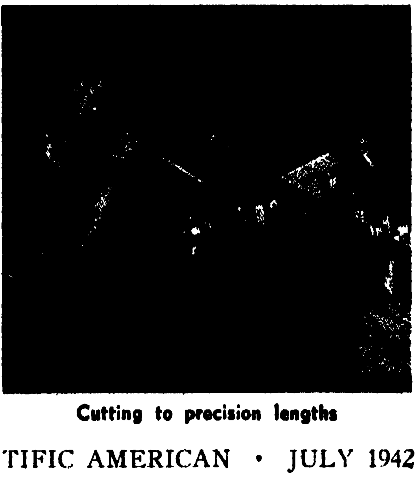


How new blind rivet is applied

CUT-OFF

Tool Uses Abrasive Wheel or Blade

A powerful and accurate unit has recently been made available for use where it is desired to cut lengths of various types of metal with a reason-



Cutting to precision lengths

able degree of accuracy and on a production basis. This unit, known as the Delta Cut-Off Machine, can be applied to any operations now performed by costlier machines or being done uneconomically by hand.

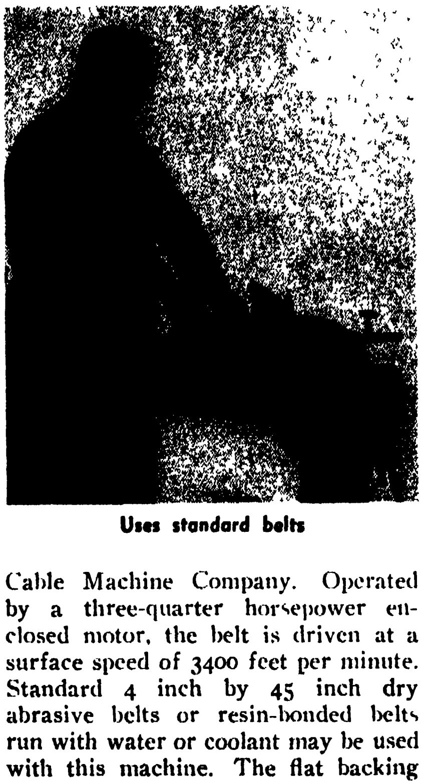
The unit is available in two models, with an abrasive cut-off wheel and with a special cutting blade for use on non-ferrous metals. Rapid cuts to exact lengths can be made on such materials as aluminum, brass, steel, Bakelite and all plastic materials, wire rope, brake linings, tile, hard rubber, and so on.

SANDER

Can Be Used Horizontally Or Vertically

For finishing operations on wood, metal, plastics, ceramics, and so on, a new floor-mounting belt sanding machine recently developed can be used in either vertical or horizontal positions.

This unit, shown in use in the horizontal position in one of our photographs, is manufactured by the Porter-Cable Machine Company. Operated by a three-quarter horsepower enclosed motor, the belt is driven at a surface speed of 3400 feet per minute. Standard 4 inch by 45 inch dry abrasive belts or resin-bonded belts run with water or coolant may be used with this machine. The flat backing plate for the belt is four inches wide and ten inches long and the rest table is adjustable to 45 degrees.



Uses standard belts

CLEANER

Works Quickly on Sheets or Castings

A new cleaner for aluminum and magnesium, known as Matawan AL cleaner, is designed for cleaning either sheets or castings. Used at a concentration of four ounces per gallon at 160 degrees, Fahrenheit, it does not produce any etch or weight loss on aluminum after two hours immersion. Machined and polished magnesium shows no weight loss or etching in 15 minutes or more. At this concentration the new cleaner, developed by the Hanson-Van Winkle-Munning Company, has cleaned a mixture of equal parts of kerosene and heavy oil in 20 seconds. In a number of tests on production castings, the time required was from ½ minute to 4 minutes for thorough cleaning, depending upon the type of work and amount of shop grease present.

FILLER

For Plastics Made from Wastes

Extension of the supply of certain plastics now curtailed because of scarcity of raw materials is seen in a new plastic filler material that can readily be manufactured from waste cellulose materials such as sawdust, scrap wood, cotton, or other plant fibers. Not a plastic itself, the new filler material, known as hydrolyzed lignocellulose, can be combined with synthetic resins of the phenol-formaldehyde and phenolfurfural types in proportions of three parts filler to one part resin. This gives a plastic comparable to that obtained from one part filler to one part resin when ordinary fillers are used, it is claimed. Thus it is possible during the present emergency to increase greatly the total amount of plastics which can be made from the limited supplies of phenolic resins now available. Both phenol and formaldehyde, the two most important resin raw materials, have been curtailed for ordinary use as a result of the large requirements of the munitions program.

The filler has been developed with the realization that standard procedures in the plastics industry must be adhered to as closely as possible. As a result, the techniques of compounding and molding continuously-hydrolyzed lignocellulose-filled phenolic plastics have been developed so that there is no major deviation from current practice, except for *an acceleration* of both operations—a result which is highly desirable. Particularly important is the reduction in the time required for molding cure, where a decrease by approximately one half greatly increases the productive capacity of the expensive molding machinery and thus reduces the number of units necessary for a given output.

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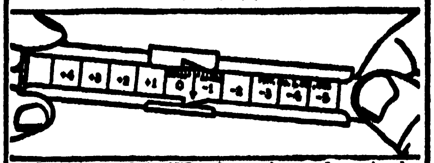

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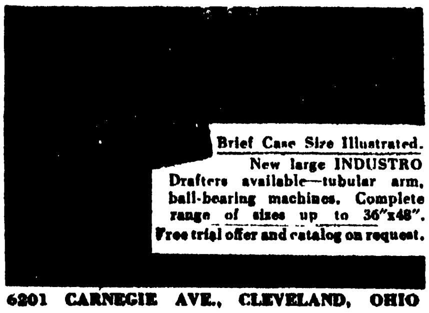

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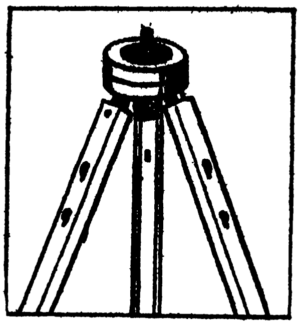

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CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Camera Multiplies Images

A SPECIAL camera, designed by W. H. Wallace, is so constructed that a single flat object, such as a simple drawing, a bit of lace, a trademark design, and so on, can be photographed by the camera to record five images of the same subject with one exposure. The basis of the camera, which is called the Kaleidograph, is the familiar phenomenon of two mirrors so placed that they meet at one end, forming a variable V. An object placed in the center is reflected in both mirrors; the narrower the angle formed by the mirrors, the greater the number of images, which for practical reasons is held to a maximum of five in the Kaleidograph.

Right: Original. Left: Multiple

The pattern photographed by the camera is made possible by the fact that duplication of the subject is achieved by reflections of reflections, the image being reversed each time it is reflected.

The camera itself is an ordinary 5 by 7 view outfit supplied with a special set of two mirrors so installed that they may be varied as to angle at the will of the operator, depending on the number of images desired or found feasible for a particular purpose. All the images are sharp, clear, and flat, without any noticeable distortion. Mr. Wallace uses a lens of the Dagor type, although any other lens, provided it is sharp-cutting, such as the process or Tessar lenses, may also be employed. Mr. Wallace uses Eastman Process Panchromatic film because, while full-color reproduction is not necessary in this work since the subjects are usually white, or black and white, the film is more sensitive to the red when used in artificial light and therefore permits quicker exposures than process ortho film would. This is important because very small stops must be used; even then, the exposure runs 15 to 20 seconds.

The re-photographed pattern

The object to be photographed is placed under heavy glass to make sure it stays perfectly flat during the exposure. The procedure involves three steps in all: photographing the object; pasting up the desired number of prints; and then re-photographing the pasteup.

Mr. Wallace says only line drawings and similar subjects are suitable. The camera can be used for halftone subjects as well as three-dimensional material, but the results are of doubtful value, according to Mr. Wallace.

Flashing a Crowd

WHAT would you do if you had to photograph a huge crowd assembled in a large square at night? Well, you wouldn't. Neither would we. But when you have to and it's your bread and butter, you find a way. That's what happened in the case of Pringle & Booth, Ltd., of Toronto, Canada, when they were assigned to photograph a crowd "estimated at over 60,000."

"Three 8 by 10 view cameras, loaded with Afga Superpan Press film, were set up side by side, with their Goerz 8½-inch lenses stopped down to *f*/16," they write. "The open-flash-shut exposure method was used, with 40 G.E. Mazda No. 75 photo-flash lamps in special reflectors. These were fired by dry cell batteries. We estimate the amounts of light at approximately 400 c.p. per square foot, or 750,000,000 lumens."

Baby Arrives!

THE amateur photographer does not exist who has not racked his brain on the arrival of the newborn to think up an original gag to announce the fact to the world—photographically. The results are not always happy ones—to the recipients, at any rate—though the sender's enthusiasm and genuine sentiment is fully appreciated. Once in a while, however, a really good idea comes through, an example of which is a card we received the other day from Maurice Lehv,

Posing pins

in which the father arranged a table-top affair showing a milk bottle and woolen booties, with the announcement, "Michael is Here!!" followed by the name of his wife and himself, all neatly spelled out in safety pins!

Prints Direct from Kodachrome

BLACK-AND-WHITE enlargements or contact prints from Kodachromes, lantern slides, and other positive transparencies, can now be made directly on Kodak Autopositive Paper. Available in two sizes, 3¼ by 4¼ inches and 5 by 7 inches, the paper is a direct reversal medium producing a positive print from the positive transparency, automatically eliminating the intermediate negative. The paper is orthochromatic and must therefore be handled under a Series I Safelight. Claimed for it are ample speed, a rich black tone, and a simple method of processing very similar to that used in making ordinary black-and-white prints, though the borders are black instead of the familiar white. These, however, can be made white by masking the image and flashing the borders before the print is processed.

Retouching Medium

INTRODUCED by Willoughby's as the latest and reportedly one of the simplest methods available for spotting and retouching, Spotone is described as a "combination spotting, tone-building, and retouching medium developed on the stain principle." Blue-black, sepia, and natural black—the three colors supplied—may be intermixed in various proportions "to produce the greatest number of retouching colors to match the largest variety of print emulsions." Spotone may be used for paper negatives and film negatives, producing grainless tone values on the latter.

Prize Winner Tells All

WANT to know how prizes are won? Listen, please, to what Nathaniel Field has to say about his prize-winning picture, "Topnotchers," which took first place in this year's Kalart Flash Contest, in addition to having won honors elsewhere in contests and pictorial salons. Interviewed exclusively for this department, Mr. Field said:

"'Topnotchers' was taken on Decoration Day at the Ringling Brothers, Barnum & Bailey Circus grounds in Newark, New Jersey. The day was exceptionally bright, with brilliant sunshine and crystal blue skies, without a sign of a cloud. I was able to obtain the co-operation of the performers, Mr. and Mrs. Hubert Castle, in a rehearsal of their act, which was performed outdoors for me.

"In planning the composition of this picture, I decided that for two reasons a low angle would be most effective:

"1. From a low angle the picture would be more impressive.

"2. Since the background was made up of circus tents and wagons, including them in the picture would create a distraction from the principal subject. However, by taking this picture from a very low angle, all of the distracting background could be eliminated.

"Topnotchers"

"To give dramatic quality, a red filter was used to darken the blue sky. For added punch, I used a Wabash Press 40 bulb in a Kalart synchronizer at the camera, with an exposure setting of f/5.6, 1/500 of a second. With this exposure, it was possible to get the performers at the top of their act without sacrificing the dramatic quality desired. The camera was an Automatic Rolleiflex, the film Eastman Super XX developed in DK-20. The print was made on Velour Black paper, developed in D-72, and toned with Tuma toner to give the print a richer quality."

Deferment for Trainees

THE School of Modern Photography, New York City, advises that, due to the need for military photographers, draft boards throughout the metropolitan area are deferring selective service draftees until they can finish their courses at photographic schools. Fifteen men have had their army induction dates postponed from two weeks to as long as six months, they report, to give the students an opportunity to graduate from the school. The Navy, they add, is doing the same.

Kodacolor With Flash

YES, you can use flash with Kodacolor. A bulletin, No. 301, just issued by Wabash, says so. It lists data and exposure tables on the flashing of Kodacolor with one bulb mounted at the camera, or two bulbs flashed in tandem. However, you must use only the daylight blue flash, as this has the higher 6000-degree Kelvin temperature that comes nearest the required lighting conditions of bright summer sunshine.

While on Kodacolor, we hear that Eastman has published a Kodacolor Exposure Guide as the newest guide in its series of Kodak Handy Pocket Exposure Calculators. It gives full data for finding correct exposure with Kodacolor under various daylight conditions.

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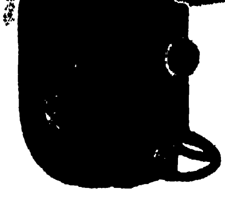

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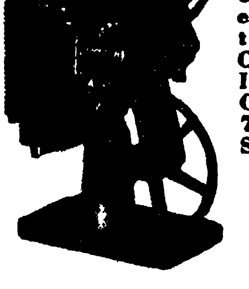

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YOUTH MUST FLY

By E. F. McDonald, Jr.

AN EXCELLENT over-all case for gliding as a basis upon which to build a truly air-minded nation which, in turn, can create an all-powerful air-transport system and a military air force second to none. Filled with an unbounded faith in American youth, the author would train these youngsters, from the early 'teens, to get the feel of the air through safe, relatively inexpensive instruction in gliders and sailplanes. From first-hand experience, Commander McDonald knows what the "ham" operators did for radio during the 1920's. He has seen these amateurs out-do the "professionals" at every turn, he has seen them accomplish the impossible, largely because they refused to be hidebound by tradition. The present generation of youngsters, he holds, can do for aviation what the "hams" have done—and are still doing—for radio. Give them the opportunity to glide, to soar with the birds, and there will be created a vast pool of sound material from which to draw the pilots and technicians of the near future. If the war lasts very long, these youngsters will be available for rapid training in the armed forces; they will have been pre-selected by their work with gliders. When peace comes, they will be as ready to further the development of air transportation as were the "hams" in the field of radio. All this and much more is forcefully developed in the pages of this book. The first three chapters, especially, give such a build-up to the sport of gliding that the reader will be completely lacking in imagination if he is not mentally carried out of his easy chair into the quiet realms of the birds. Definitely recommended reading for everyone with the least interest in aviation. (Incidentally, Major Al Williams, who as early as 1923 proposed the use of dive-bombing tactics which have since been widely used by the air forces of the world, has publicly and vigorously advocated the use of gliders for preliminary training of airmen. Commander McDonald presents Major Williams' arguments in concise form.) Covers gliding fundamentals, gliders in defense and as military weapons, a bit of history, and a glimpse of the future. Appendices deal with licenses and regulations, gliding organizations, schools and clubs, and gliders manufactured in the U.S.A. (222 pages, 5¼ by 8¼ inches, 61 photographs, drawings of manufactured gliders.)—$2.00 postpaid.—*O. D. M.*

ELEMENTS OF SPHERICAL TRIGONOMETRY

By James E. Thompson

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PLANE TRIGONOMETRY MADE PLAIN

By Albert B. Carson

ORDINARY textbooks of mathematics traditionally present only the bare bones of their subjects, usually in the most frigid, formal, conventional form. Here, however, is an author, instructor of mathematics at Louisiana State University, who departs from the "keep 'em mystified" tradition and discusses "trig" in greater detail than most authors. Not only that, but the book reads just as if the author had a heart and actually dared let the fact show through that he cared whether trig could be implanted with less than maximum suffering. This is not to say that this book makes trig easy; the student still must himself supply about 99.44 percent of the horsepower and probably always will. But the sympathetic feeling evident in this book should act as a stimulant, especially to home users. Emphasis is on practical applications more than on mental gymnastics for mere torture's sake. Logarithms are explained lucidly. The student should once have studied algebra, including quadratics, and plane geometry. Despite its five-syllable name trig isn't formidable—not as hard as geometry when geometry is first tackled. (380 pages, 5½ by 8¼ inches, 197 figures, log and trig tables.)—$2.85 postpaid. —*A. G. I.*

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By Burton and Kohl

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By Harry Donald Tiemann, M.E., M.F.

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In a review of the book "Nostradamus Sees All," by Andre Lamont, published in this department in the May number, the statement was inadvertently made that the astrologer Nostradamus foretold World War I, Nazism and other specific recent events. The intention was to state instead that the astrologer *allegedly* foretold these events.—*Eds.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

The Second Mile, by William E. Wickenden, is an eight-page reprint from *Electrical Engineering* which will serve to clarify the goal to be set before young engineers and to give a better understanding on their part of the opportunities, obligations, and ethics of engineering. It gives an enlarged professional understanding and consciousness of this unfortunately little-understood group *Engineers' Council For Professional Development, Engineering Societies Building, 29 West 39th Street, New York, New York.—10 cents per copy, $3.00 per hundred.*

An Introduction to Shipbuilding is a a 70-page text originally compiled by Bethlehem Steel Company to familiarize new shipyard workers with all phases of shipbuilding from blueprints to fitting out of crews' quarters. Its plans, its glossary of terms, and illustrative diagrams for each are now available in lively, understandable style to a ship-conscious nation through joint sponsorship of the WPB and Bethlehem Steel Company. *Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.—20 cents.*

Possible Alternates for Nickel, Chromium and Chromium-Nickel Constructional Alloy Steels is a 144-page bulletin describing four completely new series of alloy steels designed to make the nation's limited reserves of strategic metals go further and help build more materiel of war. *American Iron and Steel Institute, 350 Fifth Avenue, New York, New York—50 cents.*

Apple Varieties is a bulletin describing the important climatic and topographic features of the main apple-producing sections of the United States; insect and disease conditions; and characteristics of leading varieties. Bulletin FB1883. *Office of Information, United States Department of Agriculture, Washington, D. C.—Gratis.*

Here's How to Handle It is a 16-page illustrated bulletin describing a wide range of belt conveyors for handling bulk materials in industry and on engineering projects. Bulletin No. 410. *Chain Belt Company of Milwaukee, Milwaukee, Wisconsin.—Gratis.*

Fireproofing is a copy of a report presented to the American Wood Preservers Association for the benefit of engineers, architects and others interested in fireproofing methods for wood. *Mr. H. L. Dawson, 1427 Eye Street, N. W., Washington, D. C.—Gratis.*

Plating Conveyor Bulletin gives illustrations and detailed descriptions of the construction and improved features of these conveyors. It describes various types of drives, a wide range of carriers, methods of agitation and ventilation, and the operation of machines. Profusely illustrated. Request Bulletin SA-101. *Hanson-Van Winkle-Munning Company, Matawan, New Jersey.—Gratis.*

Fractions, Why They Are Difficult and the Remedy, is a 19-page pamphlet on the octic system of numeration. *E. M. Tingley, 221 North Cuyler, Oak Park, Illinois.—Gratis.*

Report on Experiments With Colchicine by Layman Scientists, by Eigsti and Tenney, contains practical instructions for producing hereditary changes in plants by applying colchicine to the growing portions. *University of Oklahoma Press, Norman, Oklahoma.—35 cents.*

The Next Step Ahead in Fluorescent Lighting is a folder describing briefly the newest type of cold-cathode fluorescent tubes which start instantaneously when the switch is operated, and which have numerous advantages over the familiar fluorescent tubes which have a time lag in starting. *Fluorescent Lighting Association, 509 Fifth Avenue, New York, New York.—Gratis.*

Safe Investments is a file folder containing loose inserts describing various types of protection equipment for industrial plants. These range from welders' masks, aprons, and capes through hand-protecting gloves to various types of goggles and protective clothing. *Kimbal Safety Products, 7314 Wade Park Avenue, Cleveland, Ohio.—Gratis.*

We've Come A Long Way is an elaborately produced brochure tracing the development of the American standard of life and of the part which porcelain enamels have played in this development. Partly "human interest" and partly devoted to excellent illustrations of steps in the process of manufacturing these enamels. *The Hoffman Brothers Company, Charles Street at 22nd, Baltimore, Maryland.—$1.00.*

Taylor Instruments for Pressure is a 24-page bulletin illustrating and describing various types of instruments for indicating, recording, and controlling pressures in industrial operations. *Taylor Instrument Companies, Rochester, New York.—Gratis.*

Wartime Emergency First Aid is a single sheet describing various types of first-aid equipment for factories and offices, as well as stretchers, asbestos suits, protective helmets, and other equipment for air raid protection. *E. D. Bullard Company, 275 Eighth Street, San Francisco, California.—Gratis.*

Lycoming Aircraft Engines is a four-page folder presenting flight views of the numerous types of Lycoming-powered training planes as well as illustrations and brief descriptions of five types of engines ranging from 50 to 300 horsepower. *Department B, Lycoming Division, The Aviation Corporation, Williamsport, Pennsylvania.—Gratis.*

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UNFORTUNATELY, there is no book on amateur spectroscope making — nor even an amateur's book on spectroscope using. Potential market for such a book is probably too limited to make it pay its own way (say 3000 copies sold) but this department will rejoice if any writer ever disproves this theory. Until then the amateur spectroscopist will have to do the best he can with what he has: a few technical works on spectroscopy (cited in these pages, March, 1941), and here and there a description by some amateur who made a spectroscope despite the lack of an ideal, all-around handbook.

Such an amateur is R. M. Watrous, M.D., 1924 Flora Place, Highland Park, Ill., and his account, written by request, follows:

"The concave grating spectrograph is undoubtedly the simplest of all types for the amateur to construct because it has only one optical surface, requires no collimating or objective lenses, and can be constructed to give almost any desired amount of dispersion. The essential optical part can be bought for $4.50 and up; the rest of the instrument for the most part can be made of wood and scrap brass, and does not require elaborate machining. Scientific supply houses, such as the Central Scientific Co., Chicago, list in their catalogues a variety of replica gratings made by taking collodion impressions of famous gratings ruled on glass. These are offered in three grades at three sets of prices, depending on the degree of faithfulness with which the original rulings are reproduced. The medium grade has been found to give amply good performance in the instrument to be described. Replica gratings can be obtained mounted on silvered spherical concave mirrors of various focal lengths, and one of these is the only optical part needed for a concave grating spectrograph.

"The concave grating spectrograph may have various forms, but all are dictated by the optical principle laid down by Rowland, which states that the slit, the grating, and the spectrum must all three lie on the circumference of a circle whose diameter is equal to the radius of curvature of the mirror on which the grating is mounted. The mirror and the spectrum must lie at opposite ends of one diameter of the circle, in order to have images of the slit in focus, so the only possible variations in design must be obtained by changing the location of the slit along the circumference of the circle. In practice, the parts are arranged as shown in Figure 1.

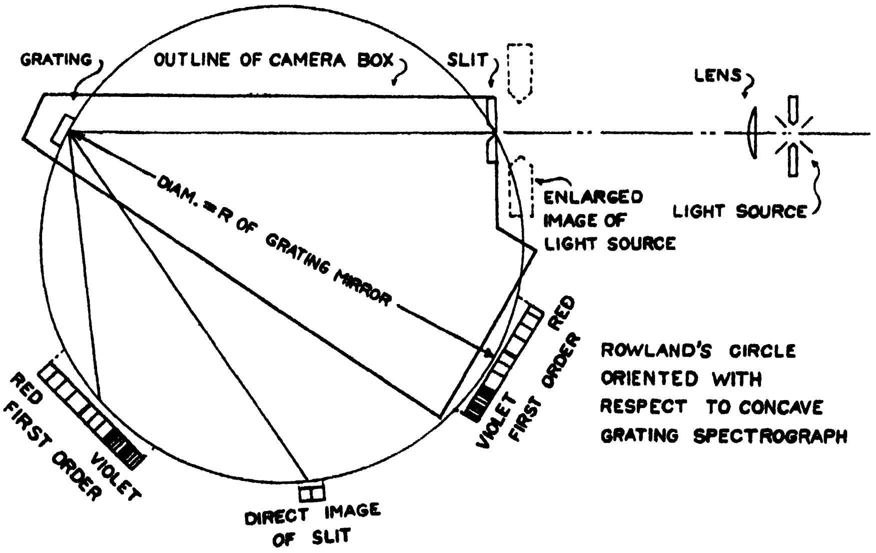
"In order to understand how images are formed by a concave grating, it is worth while to imagine the mirror on which the replica is mounted set up facing the observer as for a Foucault test, using a slit at the center of curvature as the source of light. Under such circumstances, the image of the slit will be cast back upon it, and a percentage of the light striking the mirror will be returned. However, the grating will cause some of the light to be diffracted, with the result that varicolored images of the slit will be formed both to the right and to the left of the direct image. Thus there are two first-order spectra. To the right and left of these respectively will be another set of colored images, forming the second-order spectra, and beyond these will be third-, fourth-, and *n*th-order spectra, each fainter and more spread out than the last. If the slit be now moved to one side sufficiently, and also be brought closer to the mirror, to preserve the relationships of Rowland's circle, the direct image of the slit will move in the opposite direction, as will all the spectra, until a position is reached in which the images will lie in the positions shown in the figure. By moving the slit still farther, the second-order spectrum could be brought opposite the mirror. [Detail in extension of this particular paragraph, by Dr. Watrous, may be borrowed from this department on request by readers interested in this type of spectroscope.—*Ed.*]

"Having determined the dimensions required to secure the relationship shown in the figure with any given concave grating, it is necessary only to construct a box to support the parts and exclude light, and one has a spectrograph. A film-holder may be made, to support films at the point where the spectrum comes to focus, or a telescope eyepiece may be supported at this point for direct observation With such an instrument, clear spectrograms may be obtained 8" long, showing hundreds of details such as Fraunhofer lines. The light obtained by sparking two iron nails across the terminals of a storage battery will give a beautiful line spectrum of iron. Light passed through solutions of hemoglobin, dyes, chlorophyll, and others, will show characteristic absorption bands. Bunsen's famous experiment with the sodium flame can be performed; and so on.

"In choosing a grating, a few facts should be kept in mind. The degree of dispersion (and thus the length of the first-order spectrum) is proportional to the number of lines per inch in the grating and to the focal length of the mirror. The resolving power, however, depends on the area of the grating and the accuracy of the ruling. The spectrograph shown (Figure 2) contains a medium grade grating of about 40" radius of curvature, with 14,500 lines to the inch and a grating area of about 2 x 3 centimeters

"The box is made of plywood, painted black inside, and with light baffles located at strategic points. The adjustable slit mechanism is on the left. The sliding adjustment for the film-holder is on the right, actuated by the two vertical screws. In Figue 2 the film-holder has been removed and is resting on top of these screws, its slide pulled two thirds of the way out to show how it is loaded. The main body of the camera extends into the background, with a small square porthole in the far end to give access to the adjustments of the grating mount. [In Figure 1 the slit is on the right of the spectrum but it matters not.—*Ed.*]

"The slit of a spectroscope is one of the essential parts, since every detail of the spectrum is actually an image of the slit. Its edges should be as smooth and as parallel as the maker's skill can con-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ROWLAND'S CIRCLE ORIENTED WITH RESPECT TO CONCAVE GRATING SPECTROGRAPH
DIRECT IMAGE OF SLIT

Figure 1: General plan of the concave grating type of spectrograph

trive, and one may lavish as much or as little care on it as he wishes. For ordinary work, a slit 0.002" to 0.003" in width is suitable, and there is very little actual use for an adjustable width. Provision should be made for rotating the slit mounting to line it up parallel with the ruling of the grating for best definition, and it should be mounted in a draw-tube so that its distance from the mirror can be varied slightly for focus.

"The jaws of the slit may be made of brass and should be filed to a chisel edge and then sharpened like a chisel on a flat piece of plate glass, using finishing emery. After the edge is sharp, it may be placed on a very clean, smooth piece of plate glass and gently pressed down. This will smooth out the "saw" edge and give a perfectly straight line. The two jaws should then be placed in their channels and closed gently together in front of a strong light. I believe that irregularities of less than .001" can be detected with this test The most difficult part of an adjustable slit to make is the parallel channels in which the jaws are to slide Not having a milling machine, I built these up out of strip brass. [By using a principle to be described next month, this problem is avoided.—*Ed.*]

Figure 2: Watrous' instrument

"Thirty-five millimeter film is very useful for making spectrographs, and a holder may readily be designed to accommodate strips long enough to take in the full length of the spectrum The film should be held in a curve conforming to Rowland's circle. Though it adds considerably to the problems of construction, a slide which permits the film holder to be moved at right angles to the length of the spectrum in the same plane will prove well worth while, since it allows up to ten spectra to be made on one film, with all the advantages of being lined up for comparison with one another. With such an arrangement, a narrow slit-like mask should be placed just in front of the focal plane so that each spectrum occupies a strip about 2 mm wide running the length of the film.

"The grating mount, as all telescope makers will realize, must be adjustable as to tilt in two dimensions, and it must have an adjustment for rotation about the mirror axis, in order to line up the rulings in a vertical position.

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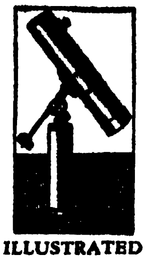

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"Carbon arcs give fine line spectra, and are excellent for collimating the instrument. Cored projection carbons, 5/16" size, will operate well on ordinary house current if the arc is placed in series with a cheap heating element or electric iron drawing about 500 watts. If the carbons are removed from this circuit and replaced by iron nails, copper wires, aluminum, brass, nickel, or lead rods, light can be produced by making and breaking the contact, which will give beautiful bright-line arc spectra of the metals. These flashes are too fleeting to study visually, but can be recorded on film and the lines can be identified with the aid of a table of wavelengths.

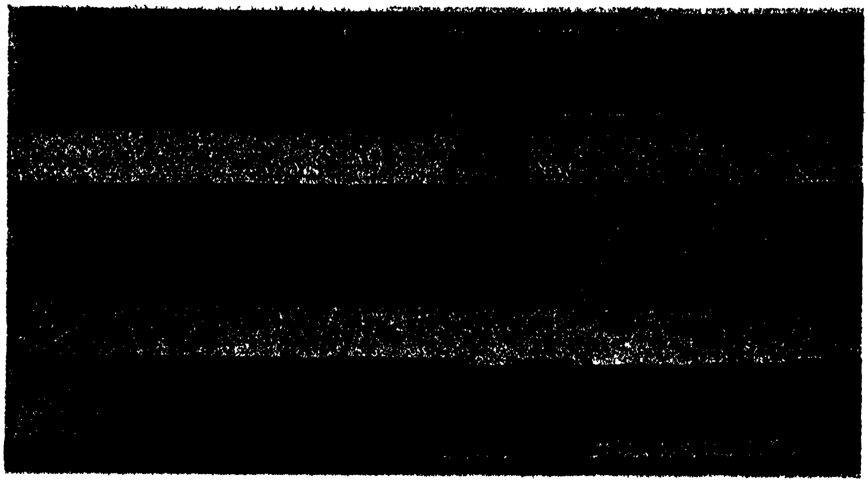

Figure 3: Spectrograms obtained with the Watrous spectrograph (see text)

"If the experimenter has a small transformer, such as is used for neon signs, he can obtain spark spectra of metals by causing the spark to jump between electrodes of the proper material. In order to obtain emission of lines, however, a condenser must be placed across the secondary of the transformer. The writer found that a home-made, one-quart Leyden jar served this purpose very well, though a more efficient and less bulky condenser would be preferable.

"The light from neon signs, fluorescent lights, and sodium vapor lamps will furnish interesting material for study and will also challenge the ingenuity of the experimenter to find some way of making it enter the instrument. On one occasion I balanced my spectrograph, which is about the size and shape of a baby's coffin, across the back seat of my car, while my wife sighted it like a rifle at a sodium vapor lamp and I held a condensing lens so as to cast an image on the slit. This was on a busy highway, but fortunately the stunt took place at night!

"Figure 3 shows three contact prints made from portions of negatives obtained in the instrument. They extend from the orange to the violet. Violet is on the right.

Top: Arc and spark spectra of metals; from top to bottom: aluminum arc; 15,000-volt condensed spark between Al electrodes; iron arc; spark between iron electrodes; copper arc; copper spark; nickel arc; nickel spark; spark between platinum electrodes.

"*Middle:* Series of exposures made with carbon arc for purpose of focusing slit.

"*Bottom:* Absorption spectra of hemoglobin derivatives: carbon arc; next two, light from incandescent portion of carbon arc passed through hemoglobin solutions; next two, same through methemoglobin solutions; next two, same through carbon-monoxide-hemoglobin (note shifting of the two dark bands to the right); carbon arc.

"The two D lines of sodium are especially prominent in most of the negatives made with light from the carbon arc. They appear near the left margin in the middle set of spectrograms, and serve as convenient landmarks.

"Brode's 'Chemical Spectroscopy,' 1939, is a fine technical work with 120-page tables of wavelengths and other things but no information on building spectroscopes. The old maestro of the subject was Baly, whose 3-volume 'Spectroscopy' was published in 1912, but this, too, is pretty technical and is no longer in print."

NEXT month two or three shorter items on amateur spectroscopy will be presented in this department.

STELLAFANE convention of amateur astronomers and telescope makers has been called off this summer. War.

FROM Thomas Hindle, England, son of the noted amateur telescope maker, J. H. Hindle, the following cablegram has been received: "Regret inform you my father John H. Hindle, F.R.A.S., died on 17th May aged 72. He was governing director of Hindle Son and Co., Ltd., and had many engineering inventions to his credit, notably the electric baling press and electric control for wide looms." It is hoped that further detail concerning Mr. Hindle will later be made available for publication in this department.

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NINETY-EIGHTH YEAR
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THE PLANE carrier, *U. S. S. Lexington*, damaged in the Battle of the Coral Sea, later sunk by American torpedoes to prevent possible usage by Japs, was a gallant ship, manned by a gallant, hard-fighting crew. The story of the *Lexington* and her sister plane carriers and the role they must play in this war begins on page 52 of this issue.

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of August, 1892)

INVENTION—"Invention being practically synonymous with new thoughts, and thoughts being the outgrowth of knowledge, the value of knowledge to the inventor is apparent, even though it may be in the nature of obscure impressions of the memory, vague suggestions from men and things, or broad yet accurate and practical information on any subject. . . . There is certainly no limit to the amount of material available. It is only necessary for the inventor to place himself in the proper relation to existing materials to enable him to reach out and take the reward."

FALLING BODIES—"An exceedingly interesting series of experiments is now being carried on in Paris, by MM. Cailletet and Colardeau, in which they are seeking to verify the law of falling bodies and at the same time those of the resistance of the air to the passage of bodies. . . The investigators have installed their laboratory on the second landing of the Eiffel tower, which gives them a free fall of about 370 feet. . . MM. Cailletet and Colardeau have employed a very ingenious electrical method of timing the fall of the variously shaped objects experimented with. . . The falling body is attached to a very fine light thread, which is divided into sections of 20 meters each. Each one of these sections is wound on a wooden cone. . . When each of the sections of 20 meters is unrolled, an electric contact actuates a registering pen upon which an electric tuning fork chronograph indicates the instant with a precision of 1-100 of a second Thus at the end of every 20, 40, and 60 meters, etc., a time record is automatically made."

TRANSPORTATION—"The removal of horses from the street cars and the propulsion of the latter by means of electricity already has been accomplished in many of our towns and cities. The day seems to be near at hand when this marvelous agent will be still more extensively employed in connection with pleasure carriages and vehicles of all kinds. In fact, the electrical omnibus now exists in London."

TIES—"A summary of five years' experience with metallic ties on the Belgian State railroads is given by Mr. Janssen. . . . Up to the time of making the report the track with metallic ties has cost for maintenance about nineteen times as much as the track with creosoted oak ties. Beyond this, many of the metallic ties are damaged to such an extent that they must soon be removed."

BEER—"The total production of beer during the past year upon which revenue was collected amounted to 31,475,519 barrels—a net increase of 1,453,519 barrels over the production of the previous year. The average annual consumption is a little less than one half barrel for every man, woman and child in the United States."

BIRTH AND DEATH—"French science has to deal with a peculiar problem, how to prevent the depopulation of the country, which is now going on so rapidly that the deaths exceed the births by nearly 40,000 in a single year. Increasing the birth rate having proved impracticable, the present hope is to diminish the death rate. . . . It is now illegal for any person to give children under one year of age any solid food except on medical advice, and nurses are forbidden to use nursing bottles having rubber tubes. Efforts are being made also to induce Parisian mothers to nurse their own infants."

TELEPHONE—"The original patent for the electrical telephone was granted to Alexander Graham Bell, of Salem, Mass., on March 7, 1876, for the term of seventeen years. The patent expires March 7, 1893. . . . The expiration of the telephone patent throws open to the public a new invention of incalculable value to the country. Its future development and expansion must necessarily give rise to many collateral new industries, furnishing wealth and employment for thousands of busy workers."

WATER-WEIGHTED—"A novel form of inclined railway has been built at Bridgenorth, England. . . . There are two cars, on separate lines of rail, and they are connected by a steel cable passing round a wheel at the top. They are thus balanced, and a preponderating weight is given whichever one is at the top, by pumping a supply of water into a tank placed in the frame of the car."

IRONCLAD—"The French ironclad Le Hoche has just given the world an object lesson in the use of the ram. On July 7, the French squadron at Marseilles was exercising, and the ironclad was crossing the roadstead at full speed, when it struck the mail steamer Marechal Canrobert (1,200 tons), then coming in from Italy, hitting her fair and full. The shock was tremendous, and the captain of the ironclad, foreseeing the consequences, ordered the steamer to be secured to his own vessel, and the passengers transferred. The fastening hawsers were then cut, twelve minutes after the collision, and the steamer instantly sank, the blow having cut her nearly in two. The ironclad remained uninjured"

POWDER—"On July 2, on the invitation of the directors of the Smokeless Powder Company, a number of gentlemen interested in military matters witnessed an exhaustive trial of the qualities of the explosives manufactured by the company. . . Five men, having the spectators at the 400 yards firing point, fired rifle volleys at 300 yards and at 200 yards, the result being that no substantial wreaths of smoke were visible. Finally, 500 shots were fired with the powder from the Maxim gun, with the result that there was very little smoke to be seen, although ten shots with black powder made an opaque cloud."

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98TH YEAR SCIENTIFIC AMERICAN AUGUST 1942

SEA NESTS FOR WAR BIRDS

Modern Warfare is Proving the Value of Aircraft Carriers

WALTON L. ROBINSON

NEXT to battleships, aircraft carriers are the largest and most costly type of naval vessel. Despite their huge size they are not, however, combatant ships in the strict sense of the term. Although several have rather heavy armaments and fairly good protection against medium-caliber shells, they are not intended to engage enemy ships in battle. Their guns are purely for defensive purposes: to beat off hostile aircraft or warships which penetrate their protective screen of fighter planes and destroyers. Their offensive strength is entirely concentrated in the squadrons of bombers and torpedo planes which they accommodate in their enormous hangars and which can quickly be put into the air from their broad flight decks.

Relatively new and untried on the outbreak of the present war, aircraft carriers have since demonstrated their great value and are now indispensable adjuncts of every large and well-balanced navy except the Italian. When operating directly with the fleet they are generally stationed about 100 miles to the rear of the battleship line. In this position they are reasonably safe from the enemy's cruisers and destroyers, although still offering an inviting and highly vulnerable target to his aircraft. A few bombs landed on the flight deck would render that particular carrier useless for the remainder of the action.

● Second of a series of analytical articles on the United States Navy, the first of which, dealing with battleships, appeared in our issue of May, 1942. Other articles will be published when and as released for publication by the Navy Department. — The Editor. ●

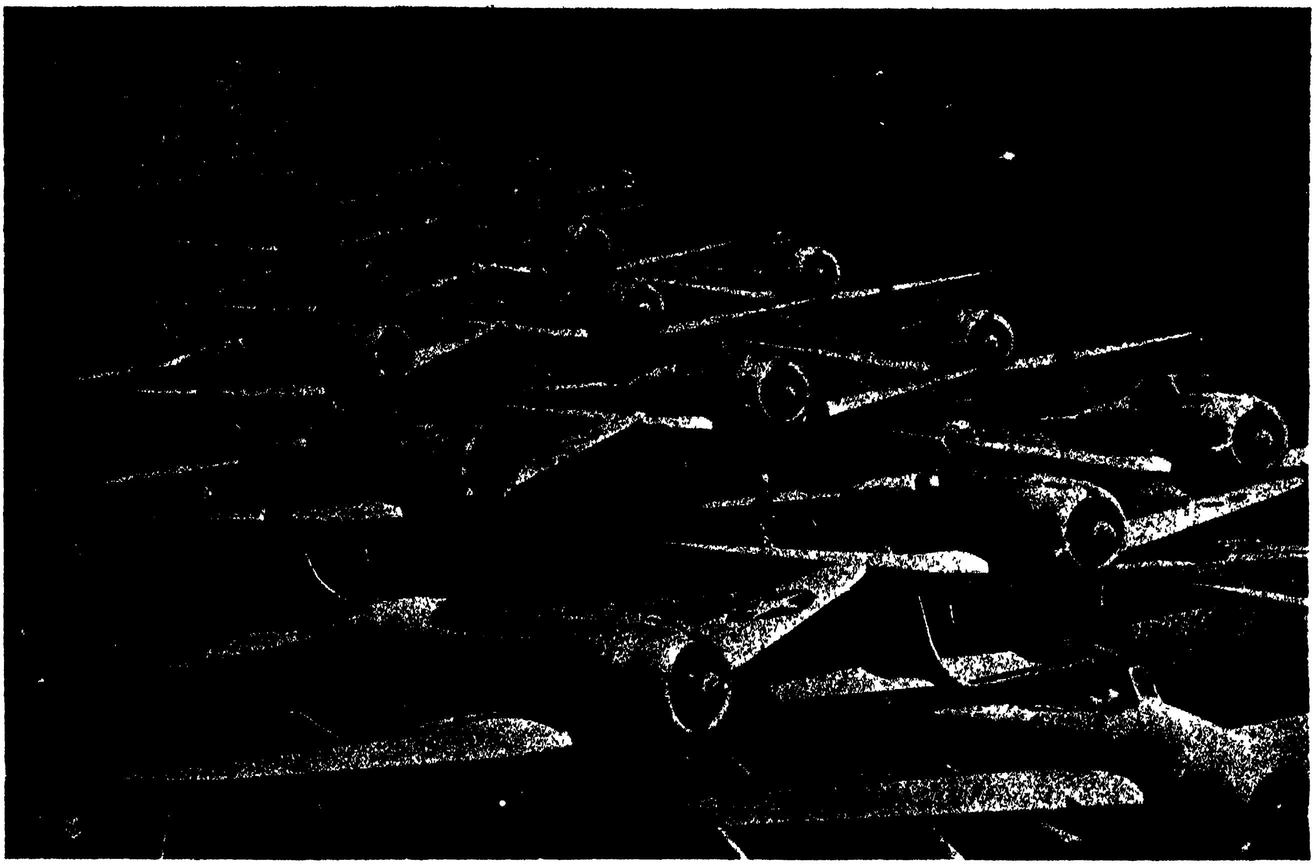
Carrier-based aircraft have won four major successes: Taranto, Cape Matapan, destruction of the *Bismarck*, and Pearl Harbor. In this last operation three or four Japanese carriers brought about 150 bombing and torpedo planes to within at least 500 miles of our great Pacific base. In successive attacks lasting all day these aircraft sank the battleship *Arizona*, destroyers *Cassin* and *Downes*, minelayer *Oglala*, and target ship *Utah*; gravely damaged several other heavy and light warships, including the battleship *Oklahoma*, which capsized; and destroyed a large number of Army planes, most of them on the ground. Defending forces shot down about 40 of the attacking planes.

The United States Navy is fairly well provided with aircraft carriers. Last December we had seven regular carriers in service and eleven others under construction or on order. Several large merchant ships, taken over by the Navy, had been or were being converted into auxiliary carriers. Two of these ships were the U.S.S. *Long Island* and U.S.S. *Kitty Hawk*. Our seven regular carriers displaced around 155,000 tons and normally operated about 575 fighting, bombing, scouting, and torpedo planes. Japan's carrier force, exclusive of a number of converted merchant ships, consisted of at least 11 units. They were, however, much smaller and slower than their American counterparts. They displaced about 173,000 tons and accommodated only about 500 planes. But that the Japanese know how to employ their carriers was amply shown at Pearl Harbor and in more recent operations in the Southwestern Pacific.

America's aircraft carriers range in size from the 14,500-ton *Ranger* to the 33,000-ton *Saratoga* and *Lexington*, largest ships of their kind in the world. The eleven under construction or on order will be ships of about 25,000 tons. Three of them are scheduled for completion next year, three the following year, four in 1945, and one in 1946. Planes and carriers to match Japan's present overwhelming air superiority in the Far East are our Navy's greatest needs today.

Our oldest carriers are the giant *Saratoga* and *Lexington*, launched in 1925 and completed in 1927 at a cost of about $45,000,000 each. They were originally authorized in 1916 as units of a class of 35,300-ton battle cruisers armed with eight 16-inch guns. After the war, but before construction had begun, their design was altered and displacement increased to 43,500 tons. The *Saratoga* (Battle Cruiser No. 3) was laid down September 25, 1920, by the New York Shipbuilding Company and the *Lexington* (Battle Cruiser No. 1) January 8, 1921, by the Fore River Shipbuilding Company (now the Bethlehem Steel Company). Work on them and their sister-ships *Constellation, Ranger, Constitution*, and *United States* had not progressed very far, however, when early in 1922 the Washington Naval Treaty put a stop to further competitive building of capital ships by the world's five principal sea powers. In accordance with the terms of this treaty Congress on July 1, 1922, authorized the conversion of the *Saratoga* and *Lexington* into aircraft carriers. Their four sister-ships were broken up on the building ways in compliance with the same treaty. The scrapping of these fine ships and of seven powerful dreadnoughts, not to mention that of 20 older battleships in service, was America's magnificent but futile contribution to the ideal of disarmament and world peace.

THE *Saratoga* and *Lexington* have a standard displacement of 33,000 tons; fully loaded they displace over 40,000 tons. Their length on the waterline is 830 feet and their over-all



U. S. Navy Official Photo

Navy planes warming up on the deck of a carrier, preparatory to the take-off

length, which includes the overhang at bow and stern, 888 feet, making them the longest warships ever built. An extreme beam of 105½ feet barely enables them to squeeze through the Panama Canal locks. At full load they draw 32 feet of water.

These two carriers mount what in reality is the most formidable armament ever provided in ships of their class. They carry eight 8-inch guns, twelve 5-inch anti-aircraft guns, and numerous smaller weapons. Their 8-inch guns are 55 calibers in length (that is, 36 feet, 8 inches), elevate to 30 degrees, and hurl a 250-pound shell at a maximum range of some 28,000 yards or about 16 miles. They are mounted in pairs in four armored gunhouses along the starboard side of the flight deck, where they enjoy an exceptionally wide arc of fire. It is this excellent distribution of their 8-inch guns which makes the *Saratoga* and *Lexington* actually the most heavily armed carriers in existence. Two Japanese ships, the 26,900-ton *Kaga* and *Akagi*, mount ten 8-inch guns, but these are mounted singly along the ships' sides and well below the flight deck with the result that only five of them can bear on either beam. Consequently, these Jap carriers have a broadside fire of only five 8-inch guns.

The twelve 5-inch, 25-caliber anti-aircraft guns, firing shells weighing about 50 pounds, are mounted singly along the ships' sides. They are grouped in four positions just below the flight deck, which is somewhat recessed to give them as wide an arc of fire as possible.

The *Saratoga* and *Lexington* each has a maximum capacity of about 106 aircraft; under normal conditions, however, only some 80 are carried. Normal complement consists of a complete Air Group of four 18-plane squadrons plus a number of reserve and utility planes. The *Saratoga*, as flagship of Carrier Division One, Battle Force, Pacific Fleet, has, in addition, a two-plane flag unit. One of her squadrons consists of scouting planes, another of bombers, a third of fighters, and the fourth of torpedo planes.

These aircraft are housed in the spacious hangar located just below the flight deck. Here also the planes can be fueled, repaired, and loaded with bombs or torpedoes. Two large elevators convey them from the hangar to the flight deck. This latter, 880 feet long and 85 to 90 feet wide, is 60 feet above the water-line. At the bow, a catapult, 155 feet long, launches the heaviest planes into the air at a flying speed of better than 60 miles an hour. On the starboard side are two powerful derricks for lifting seaplanes and flying boats out of the water.

The defensive characteristics of these great ships have never been officially disclosed, but they are believed to include a wide 6-inch armor belt running some 600 feet along the water-line, a 3-inch deck over such vital spaces as the magazines and engine- and boiler-rooms, triple hull construction, and anti-torpedo blisters or bulges. This protection, particularly the deck armor, may recently have been improved.

THE *Saratoga* and *Lexington* were designed for a speed of 33.25 knots, which they both have exceeded in actual service. Their machinery—General Electric turbines with electric drive—is the most powerful ever installed in a warship. Sixteen boilers with a pressure of 295 pounds per square inch provide steam for the turbo-generators which supply current for the eight 22,500 horsepower electric motors. Two of these motors are connected to each of the four propeller shafts. On one occasion the *Lexington* made the 2228-mile voyage from San Diego to Honolulu at an average speed of 30.7 knots and on another maintained a speed of 34.5 knots for one hour. Fuel oil capacity is 7000 tons, an enormous amount, but not

U. S. Navy Official Photo

Eleven more of these important naval vessels are under construction or on order for the United States Navy, as of June 1, 1942

excessive in view of the daily consumption of some 2000 tons when the ships steam at full speed.

Although sister-ships, the *Saratoga* and *Lexington* are not identical in appearance. They can most readily be differentiated by the platform around the top of the latter's funnel. This platform is lacking in the *Saratoga*. Both ships can easily be distinguished from any of our other carriers by their huge flat-sided funnel. This funnel, which is really a single casing enclosing a number of boiler uptakes, rises 79 feet above the flight deck. Whatever its merits, it certainly offers an excellent target to the enemy.

Our first carrier originally designed as such is the 14,500-ton *Ranger*, authorized in 1929 and laid down two years later by the Newport News Shipbuilding Company. She was launched February 2, 1933, and commissioned for service 16 months later at a cost of about $19,000,000. Her water-line length is 728 feet, her beam just over 80 feet, and her mean draft 19 2/3 feet. Her complement, including flying personnel, amounts to some 160 commissioned officers and 1650 enlisted men.

The *Ranger* mounts eight 5-inch, 25-caliber anti-aircraft guns, sixteen 1.1-inch machine guns, and 24 smaller ones. Her armor protection is very scanty, comprising only a one-inch deck and a thin patch of side plating over the engine- and boiler-room spaces. For defense against torpedos, mines, and near bomb misses, she relies on her double hull and internal sub-division below the water-line.

Recently the *Ranger* has been carrying 84 aircraft, which is just about her maximum capacity. Two of her four squadrons are composed of scouting planes and the others of fighters. A dozen reserve and utility planes complete her brood.

Aside from being our smallest and most lightly protected carrier, the *Ranger* is also the slowest. Her 53,500 horsepower geared turbine engines, driving two propellers, give her a designed speed of 29.25 knots. On trials she just exceeded 30 knots with 58,700 horsepower.

The *Ranger* differs radically in appearance from our other carriers. On the starboard side on her flight deck she has a small island superstructure and a short tripod mast, but her funnels or smoke ducts, of which there are no fewer than six, are located near the stern, three on each side of the flight deck. They are very thin and short and can be lowered outboard in a horizontal position while aircraft landing-on operations are in progress. For the past several years she has been assigned to Carrier Division Three, Atlantic Fleet.

The 19,900-ton *Yorktown* and *Enterprise*, authorized in June 1933, were laid down in May and July of the following year at Newport News. The contract price for their hulls and machinery amounted to $38,000,000, but the actual cost worked out at a considerably higher figure. Including armament and aircraft, these ships cost around $25,000,000 each. They were launched in 1936 and commissioned for service two years later. Their completion and final acceptance by the Navy was delayed by serious mechanical defects which developed in their engines and boilers. In the *Yorktown* this trouble necessitated the replacement of the reduction gearing and of more than 1200 boiler tubes.

The *Yorktown* and *Enterprise* are 761 feet long on the water-line, 809 1/2 feet over-all, and have a beam of 83 1/4 feet and a mean draft of 21 2/3 feet Their flight deck, which commences some 15 feet short of the bow and extends about the same distance beyond the stern, is approximately 800 feet in length.

These ships carry eight 5-inch, 38-caliber "dual purpose" guns, sixteen 1.1-inch anti-aircraft machine guns, and numerous smaller weapons. The

(Please turn to page 82)

Motion Study Goes Human

Workers Co-Operate in Achieving Increased Production Efficiency Through Time and Motion Research

ALBERT RAMOND
President, The Bedaux Co., Inc.

At a table in a factory office a lone watcher sits behind a portable movie projector, facing a portable screen. As he watches the screened action, he writes occasionally on a sheet of paper—writes a kind of engineering shorthand. And this watcher differs further from the ordinary movie fan in that never does he say, "Well, this is where I came in," and get up and walk out. Rather, he sits through the same sequence over and over; and as his film, in the form of a loop that does not require rethreading, spins through his projector again and again, he goes on writing.

Now he snaps off the projector motor switch and, operating the machine by hand, examines his picture frame by frame And still he writes.

. . Thus, with the aid of motion photography, which suffers no slips of memory, overlooks no details, and measures time in thousandths of a minute, modern-day scientific management goes about the task of streamlining production methods in many of America's war industries, conferring benefits alike on worker, employer, and on the all-out war effort. By means of movies, filmed in electrically-driven cameras whose speed is synchronized precisely with the speed of the projectors, production engineers are enabled to study workers' motions in order to improve and simplify methods of work.

Motion study is but one of the tools in the modern production engineer's kit. Scientific management, an extension of a field first explored by the late Frederick W. Taylor, concerns itself also with such matters as time study and establishment of production quotas, plant layout, planning, scheduling and routing of the production flow, training of workers and supervisors, and incentive plans to reward workers equitably for extra effort.

And in every step of the procedure of improving production and management methods, modern-day scientific management enlists the workers' interested co-operation, thus insuring between management and labor the wholehearted kind of teamwork that America's wartime production job demands. The techniques employed produce substantial results.

To cite a recent instance, production engineers, in a plant that produces gun mounts and earth-moving equipment, helped increase output in a bottleneck department by 102 percent. Meanwhile, thanks to the workers' increased productivity, wages went up while costs declined.

In this instance, it was the engineers' findings, derived from study of the movie records of workers' motions, that led directly to the department's improved achievements. Here, as in many other instances, motion study disclosed a need for jigs and fixtures for holding and rotating heavy work; and here, as has often been found in other cases, the installation of jigs and fixtures not only stepped up production but also reduced the workers' fatigue and contributed to their safety

Let's look as this last-mentioned phase of the matter more closely. As the engineer - turned - photographer watches his movie film unroll, he keeps vigilant watch for signs of wasted energy—signs that experience in similar studies in many other plants has taught him to expect.

Let's assume that, in the course of his step-by-step survey of the operations in a plant department, he has set up his camera and photographed a worker's cycle of operations at a punch press Now, as he sits behind his projector to run off and to study the photographed record in detail, the engineer watches for the answers to such questions as these.

Are the worker's motions symmetrical—that is, do the right and left hands reach, grasp, carry, hold simultaneously; or does one hand frequently wait for the other? Is the work so arranged that motions are short and smooth; or are they long and jerky? Can the working surfaces be so arranged that work need not be picked up, but may be slid into place? Can the weight of the work be reduced? Are there periods during which a hand or an arm must assume a cramped position—perhaps to hold work in place—and will a jig or fixture reduce fatigue and enhance accuracy?

Thus, step by step, the engineer diagnoses. Next he prescribes. Motions, work arrangement, jigs and fixtures—all details are noted that need correcting. On paper he creates an improved work-cycle. Then, back at the punch press, the new routine is explained to the pressman.

"Looks better," the pressman concedes.

"Try it," the foreman suggests.

The pressman tries it and says, "It *is* better."

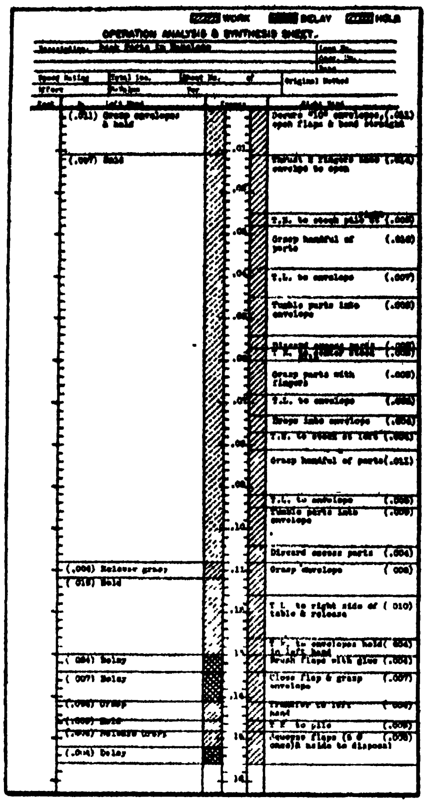
"In a few days, after you've got the hang of it," the foreman tells him, "We'll bring the camera back and shoot another picture. I think we'll be surprised at the difference."

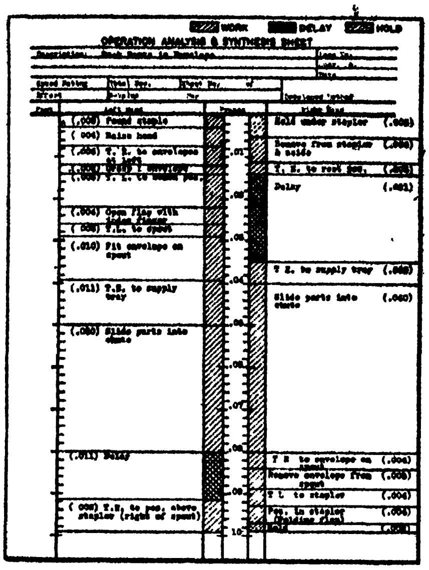
Seldom, however, is the engineer greatly surprised; experience has taught him that when the second loop of film comes back from the developers it will run but half or at most two thirds the length of the first. That much motion and time will have been saved. And the engineer, having run the second version through his projector for checking, may recommend still further changes in method, or he may file it away for future reference—and for use, perhaps, in training other workers.

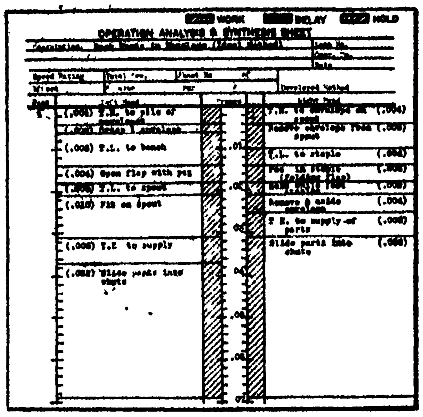
Thus, step by step through a department or through a factory, motion study discloses the little energy losses —losses that, added together, a few seconds here and a few seconds there, have been found to add up to hours and hours of time.

Time study was mentioned a few paragraphs back. The primary object of time study is to measure work accurately and, by scientifically determining normal rates of production, to obtain a yardstick for comparing what is being accomplished with what could be accomplished under reasonably efficient conditions. Such a study, often coördinated with motion study —in fact, the two are frequently carried on simultaneously—makes possible setting of equitable rates of pay, with extra reward provided for extra effort.

Here must enter the workers' enlightened understanding. In one large plant the time-study man is the president of the employes' union. Collaborating thus, guided by accurate time studies, and allowing liberally for fatigue and other factors that influence production, both management and labor may feel sure that the wage rates that result will be fair.







Results of a camera analysis of a simple bench operation consisting of placing a number of small spare parts in a paper envelope. The operation as originally observed took up the time of 156 frames of motion-picture film, in which one frame is one exposure corresponding to 1/1000 of a minute. The operation cycle was, therefore, .156 of a minute. The most noticeable thing disclosed by this study is that the right hand (chart at extreme left) is working for the entire cycle, while the left hand is working for only .012 of a minute and is used for holding for .129 of a minute or about 83 percent of the cycle. By re-locating parts on the bench and re-allocating the work on both right and left hands, the total cycle was brought down to .099 of a minute (chart in center), a reduction of 36½ percent. Then the stapler used to close the envelope was modified to be foot-operated. This permitted a further reduction of the cycle to .069 of a minute, or 30 percent more, giving a total reduction in time, over the original of nearly 56 percent (chart at right). With the foot-operated stapler, both hands are used in a productive manner all of the time except that the right hand holds the parts under the stapler for a period of .003 of a minute

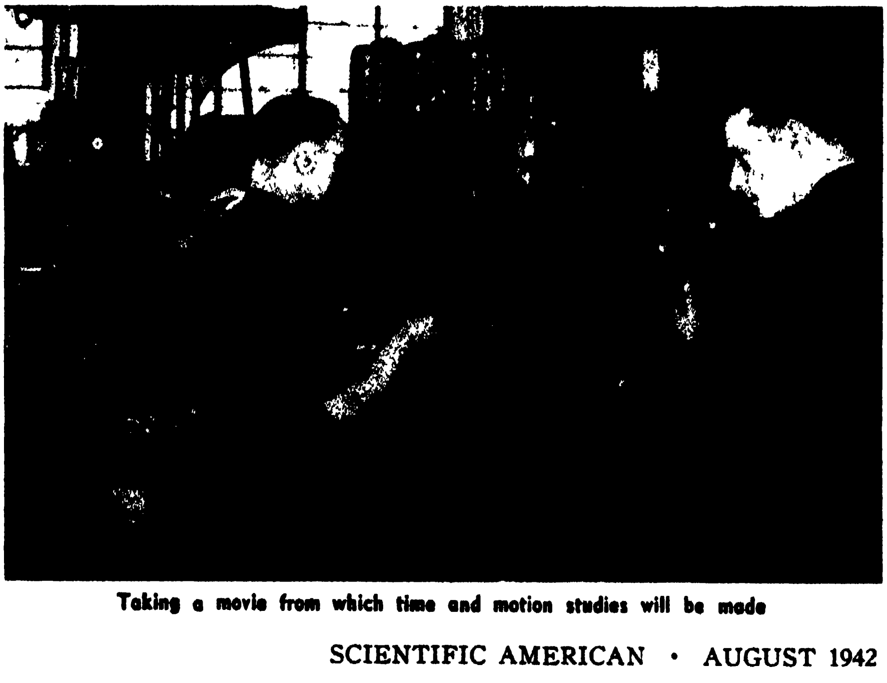
Time study does even more than this. Because it records elapsed time in terms of productive and non-productive effort, it highlights time-losses and the reasons for them. These reasons may include defects in plant lay-out, or slips in planning and scheduling the production flow from machine to machine, or from department to department. Or the losses may be due to delays in receiving materials, tools, or instructions.

In an ordnance foundry, better planning and a complete overhauling of the method of compensation—permitting workers to earn more when producing more—resulted in increasing output by 110 percent. In this plant the erstwhile slowest worker now is the fastest. Methods had been improved. Potentialities for earnings—his own and his colleagues'—had been increased. Should he, who used to be the laggard, now become a one-man bottleneck and slow down a whole department? Not he! Promptly, he stepped out in front; and, as a producer, at this writing he still leads.

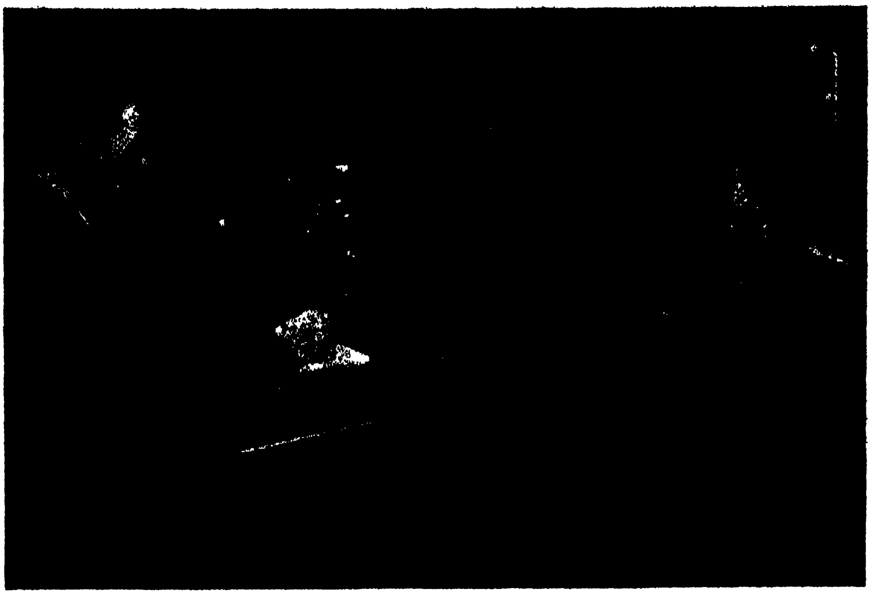
In a steel-casting plant that, among other things, makes anchors for warships, production engineers found that nearly everyone, at one time or another, stood around, waiting. The engineers found moulders waiting for sand and for patterns. They found pattern makers waiting for orders. They found truckers, trundling their trucks through the aisles between the moulders, waiting for the moulders to get out of their way.

Again the engineers prescribed re-arranging, rerouting, and rescheduling. Orders, it was provided, would go to the pattern shop fore-handedly enough so that patterns would reach the mouders on time. Sand would go to the moulders, not through the aisles—which were the moulders' working space—but along the rear, and thus clear the working space for work. At one spot, a stoppage-point in plant traffic, a flight of stairs was replaced by a ramp to make easier the trip from one level to another. Rearranged, this plant stepped up its production 96 percent—and workers' earnings went up substantially.

To be sure, not always are production delays so obvious; but, in times such as these, when production, because of pressure of the war demand, often must be gotten out by main



Taking a movie from which time and motion studies will be made



A motion-study engineer views a loop of film over and over again

strength, even glaring delays are frequently tolerated because they seem to be necessary evils. But trained observation just as frequently shows that these evils are not necessary at all.

Detailed study of operations almost invariably reveals certain bottlenecks—sometimes divisions or whole departments—the true effects of which have not even been suspected. Thus, in a plant that makes seamless tubing for aircraft, job studies disclosed that stoppages in the annealing department could be eliminated by assigning certain technical tasks to the personnel of the plant laboratory instead of to production men as had been former practice. When the stoppages had been cleared, the plant's over-all production went up 42 percent.

Not only in enterprises where operations are repetitive and more or less standardized, but also in maintenance and repair work and in those fields of industry where each successive operation may differ from those that have gone before, modern methods of production control have stepped up output. For example, a warehousing operation that handles steel sheets, bars, angles, and other steel shapes—all essential materials in our industrial war program—ran far behind its service potential, until production engineering technique rearranged such warehousing functions as classifying, segregating, stacking, inventorying, and even cataloging. These improvements, together with a replanning of the crane service, enabled the warehouse to improve its over-all performance by 44 percent.

SIMILARLY, it was an overhauling of layout and a rerouting of the flow of work that enabled production engineers to bring about a seeming miracle in the maintenance department of a great steel mill. In this mill, rearrangement of planning methods brought about production increases in four major repair shops, ranging from 72 to 128 percent. Incidentally, with equipment scarce and with machinists becoming still scarcer, proper control of maintenance work in almost any kind of factory becomes increasingly vital.

Fortunately, both labor and management well realize today that in winning the war each side has a stake. On an ever-broadening front, labor has accepted as socially and economically sound the principles of scientific management and has participated in their application. In part this attitude is the result, of course, of the war program. In part, and even more important in the long run, it is the result of the adoption by management of a broader, enlightened labor policy

Through the years, one of labor's major objectives has been greater security. And because, through these same years, *efficiency* came to be linked in the workers' minds with loss of jobs, the word became unpopular. Meanwhile management, having come to realize that in its employe relations a good deal was lacking, had begun to overhaul its personnel policies and its methods of production control It is to further this overhauling - this humanizing—of policy that present-day production engineering, far from laying aside the techniques of scientific management, now applies those techniques with labor's co-operation

ARE the methods of a factory to be examined and improved? Openly, frankly, and fully, supervisors and the production engineer talk the matter over with the men. Are operations to be studied in detail? The workers help. They know what is afoot and—more importantly—they know why. Are wage rates to be established? The workers are taken into the procedure The workers do more. In instance after instance, having watched production engineering step up output, they have gone on the alert for opportunities for still further improvement; they have come to management and said:

"Look here! Everything's fine as far as we've gone; but we haven't gone far enough. At least, *you* haven't. Here is something you have overlooked."

That something usually turns out to be a managerial blind spot—a lapse in planning or supervision. The bottleneck eliminated, the workers say:

"O.K.! Now we can go places with this plant!"

Time after time, experience has proved that a proper approach to a solution of the problems involved in increasing production brings a favorable reaction from everyone concerned. A broader application of these principles—a development for which management must assume the primary responsibility—would provide a vital stimulus for our war effort.

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IRON-GLASS SEAL

Made Possible by New Invention

TIGHT seals between iron and glass, eliminating the need for nickel and cobalt, critical war metals, for wires leading into certain types of vacuum tubes, are now being made with a new development of Dr. Albert W. Hull and Dr. Louis Navias, General Electric scientists.

From early days of the electric lamp, a problem of construction has been to make a tight seal between metal and glass. It is also involved in making radio tubes. Even with tubes in which the glass shell is replaced by one of metal, the lead-in wires pass through glass insulating bushings.

The difficulty is that most kinds of glass expand with heat at a different rate from that of the metal. Glass and metal may be tight at one temperature, but when they are heated, the glass will either crack or pull away from the metal, because the change in their dimensions is not the same.

Platinum was used in the first electric lamps, since it has nearly the same rate of expansion as the glass then employed. Various substitutes for platinum were devised which were satisfactory for lamp seals, though they were not adapted to the large seals used for powerful vacuum tubes, for example. However, Dr. Hull and others developed special nickel-iron-cobalt alloys for this last application.

Since nickel and cobalt are used in many ways for war equipment, and their supply is extremely limited, the new invention of Dr. Hull and Dr. Navias is an important one since, for certain applications, it permits tight seals to glass without their use. They have devised a series of glass compositions which can be used with iron and certain iron alloys. One consists of 45 percent silicon dioxide, 14 percent potassium oxide, 6 percent sodium oxide, 30 percent lead oxide, and 5 percent calcium fluoride. The rate of expansion of these glasses is very close to that of iron.

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FORGERY—Many forged checks can now be detected instantly at a bank teller's window by means of an ultra-violet ray lamp developed in Westinghouse laboratories. All checks are coated with fluorescent chemicals which glow brightly in the dark when irradiated with invisible ultra-violet. Any erasure or change on the checks removes part of the chemical coating even though the alteration cannot be seen in ordinary light. Under ultra-violet the tampered part of the check shows as a dark blotch.

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STANDARD STEELS

Can Speed-Up Production For War Needs

Production of steel for war equipment is being facilitated as steel producers and consumers concentrate more and more on making and using a relatively small group of standard steels rather than literally thousands of special-order steels.

The standard steels on which emphasis is being laid consist of a group of 87 alloy steels and 77 carbon steels selected after a two-year period of study and research by top-ranking steel plant operating executives and outstanding metallurgists working through the American Iron and Steel Institute. Hitherto, carbon and alloy steels had been made in more than 4000 different combinations of chemical elements.

Last year the groups of standard steels represented approximately 90 percent of the total output of carbon steel, 70 percent of the alloy steels made in open hearth furnaces, 85 percent of the electric furnace alloy steels, and 100 percent of the stainless steels.

In 1942, it is expected that standard steels will constitute an even greater proportion of the total steel output.

Steel plant efficiency has materially improved along with the greater production of standard steels, and both producers and consumers are sharing the advantages of large-scale production.

Efficiency has been improved in many ways. By enabling steel plant operators to assign a furnace to the more or less continuous production of one class of alloy steel, such as chrome-molybdenum, the crews which work on the furnace on the present round-the-clock schedule have a chance to improve their performance by specializing in producing that one class of steel. When a great variety of specifications had to be met, it was more difficult for the crews to develop a routine of high efficiency.

Standardization also has resulted in fewer "off-heats" which must be discarded or diverted because they do not comply with consumer specifications.—*Steel Facts.*

PLANE CONTROL

Made Smoother by New Rubber Bushings

The development of a new material to be used for bushings and guides of the primary controls of an airplane has just been announced by the research department of The Firestone Tire & Rubber Company. This new material is a composite construction of a special rubber compound, a special cotton fabric, and a new method of impregnating the assembly after vulcanization.

Because of its elastic properties, bushings and guides of this new material provide, without restriction of action, a tighter fit than has previously been possible with conventional type guides and bushings. Combining shock absorption qualities and the ability to minimize lost motion, it contributes to smooth operation of the plane

The new material is being used mainly in bushings and guides for the rudders, elevators, and ailerons of planes.

REFLECTOR

For Fluorescents Releases Steel for Other Uses

Development by the fluorescent lighting fixture industry of a new-type reflector, constructed of materials not vital to war production, was announced recently by the Lighting Division of Hygrade Sylvania Corporation. An industry-wide change-over to this type of reflector would release, for more critical war production, important quantities of steel currently used in reflector manufacture.

Because fluorescent lighting makes more efficient use of electrical power and provides more light of better quality, it is considered an extremely important factor in 24-hour-a-day war production. It is being used in a great majority of war production plants, and thousands of fixtures are being manufactured for this purpose daily. The fixtures utilizing the new composition reflector will employ only about 1/3 as much steel as present fixtures, and thus the amount of steel made available for other war production will be considerable.

Made of a specially treated composition, the reflector is considerably lighter in weight than present reflectors. General appearance, however, remains the same. The reflecting surface is the same high-temperature synthetic enamel used on many present Hygrade fixtures, and has equally high light reflectivity

Out come new reflectors

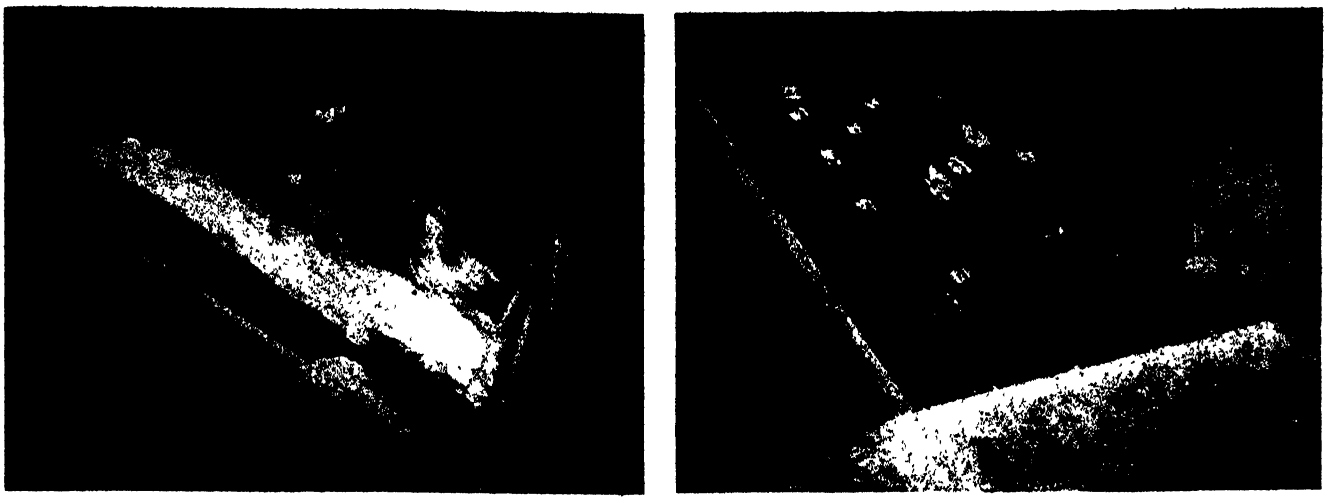
FIRE RESISTANT

Roofing Proved in Grueling Tests

Few home owners think of the roof as one of the most fire-vulnerable parts of a building, yet sparks landing on combustible roofs have been responsible for 55 of every 100 conflagrations in this country since 1900, according to figures compiled by the National Fire Protection Association.

On the other hand, there are instances where fire, sweeping across a section of a city, has stopped when it reached a community in which fire-resistant roofs were in the majority.

The choice of roofing, therefore, is not one for the individual alone, but for the community as a whole, to influence. More than 600 cities and towns in the United States permit only fire-resistant roofing within their fire limits, and this number is growing



***Left:* Wind-blown flames melt asphalt, do not set roof deck aflame. *Right:* Firebrand test**

almost daily. Either in peace or in war, such protection is a first line of home defense.

Much of the credit for the present high standards of fire-resistant roofing belongs to the Fire Underwriters' Laboratories in Chicago, which, as one of its many fire-protective functions, tests and classifies roofing according to the fire protection it will provide under actual fire conditions.

Testing and classifying of fire-resistant roofing is done by duplicating roof construction and fire conditions at the laboratories. A section of roof, built of wood like that of an average house, and covered, for example, with asphalt shingles, is placed on an inclined framework before a wind tunnel. In the mouth of the wind tunnel there is a three foot wide gas flame This flame, with the gas pressure carefully regulated, is then blown against the surface of the roofing by a 12-mile-an-hour wind from the tunnel. The flame is applied intermittently, two minutes on and two minutes off. To pass this test successfully, there must be no flaming on the underside of the roof deck at the end of the test period.

To determine the protection which asphalt roofing—the most widely used fire-resistant roofing—will provide against the danger of flaming brands being blown on to it, further tests are made with actual burning brands of various sizes. These are placed on a new test sample and allowed to burn themselves out. Here, again, the period should end with no flaming of the underside of the deck.

A third test measures the ability of the roofing to prevent the spread of flames. In this case, a 1400 degree, Fahrenheit, flame is blown continuously against the surface of the roofing; the distance which it progresses is noted. This indicates whether the roofing adds any fuel to feed the fire

These tests, combined with several others, determine whether or not the roofing is readily flammable, and whether or not it carries or communicates fire. They also show the degree of heat insulation the roofing provides for the combustible structure underneath and whether—in a fire—the roofing will slip from place and create a flying brand hazard

• • •

WIRE—A strand of wire reaching from New York to Montreal, a distance of 469 miles, can be produced from a rod of tungsten 5½ feet long having a diameter slightly larger than a lead pencil.

• • •

TEST SAVING

By Generating Electricity With Airplane Engines

NEW airplane engines which once consumed great quantities of aviation gasoline but did no useful work during break-in runs now have been harnessed to produce enough electric power to supply all machines and lights in the factories where the engines are built, according to R. H. Wright, an engineer at the Westinghouse Electric & Manufacturing Company.

"In this way, one new airplane engine on test actually drives machine tools producing parts for other engines and at the same time saves electricity needed for other war factories," said Mr. Wright.

The new power-producing method has been achieved by harnessing the airplane engines to ordinary electric generators of the type long used in small Diesel-electric power plants. Westinghouse already has supplied one large airplane engine manufacturer with 16 of the generators Mr. Wright continued:

"Every airplane engine runs about half a day in a specially constructed test cell before it is built into one of our fighting skycraft. It is first given what aeronautical engineers call a 'green' run to unlimber it. Then the engine is taken apart, inspected, and reassembled for a final break-in run.

"In some engine factories, 40 or more of these cells are in use continuously. As a result, engine manufacturers are among the largest users of aviation gasoline For example, in one plant, engines on test have burned more than 1,500,000 gallons of this fuel in one month."

By installing generators in test cells, each aircraft engine can produce about 2000 kilowatt-hours of electrical energy during its test runs Mr. Wright explained. Generators now in use in one factory will produce each month more than 4,000,000 kilowatt-hours, worth about $24,000. That much electricity is enough to supply the entire factory — driving lathes, drills, grinders, boring machines and other machinery used to manufacture airplane engines—including lights. In less than two and one-half years, it is estimated the generators will pay for the additional cost of installation.

The generators can also operate as motors to crank the stiff, new engines for their first trial run. Then, after the engines gain speed under their own power, the electrical machines automatically become generators, producing power instead of using it. By measuring the amount of electricity generated, engineers can tell whether the engine is running properly. Such accurate checks are not possible when the engines drive propellers in test cells not equipped with generators.

Test cells that use generators can be built smaller and less expensively. Propellers make so much noise that their cells must be built larger and with sound baffles to keep them from being a civic noise nuisance.

INDUSTRIAL TRENDS

RUBBER COMPANIES, AS CONVERTED

THE fact that rubber is vital to the conduct of a modern war has been hammered home so thoroughly that it hardly seems necessary to give it even one more tap. We can, therefore, in this column dismiss for the moment this well-understood fact, and also disregard the subject of natural-*versus*-synthetic elastomers, to pass along to certain data of interest regarding the rubber companies themselves. From such data can be obtained a clear picture of the entire rubber industry as it stands today; from this picture can be deduced with some degree of certainty the general trend.

When the average person thinks of the products of a large rubber company, the first thought is, quite naturally, of vehicle tires. Yet, in peace-time, over 30,000 different products make use of rubber in one form or another and it is this versatility that makes rubber of such tremendous value in times of war. The manufacture of such a wide range of products calls for the application of research and engineering knowledge of no small moment, and for a diversification of such knowledge in many fields that, ordinarily, would not be considered in any way related to the rubber industry. This knowledge—the fashionable word of the moment is "know-how"—is essential for progress in the commercial world of peace; in war-time it becomes invaluable to the country holding it. Up to the start of the war it led the rubber companies into many new fields, and in some measure prepared them for what was to come.

As a result, a general survey of the five largest rubber companies shows that all of them are managing arsenals Individual tire-makers are producing in large quantities such war material as airplane sub-assemblies and anti-aircraft gun carriages. One company is turning out machine tools, while the industry as a whole is in production on barrage balloons for protection against enemy aircraft. Such, briefly, is the over-all view. Let's look closer at the five largest rubber companies.

Goodyear: Normally the world's largest tire producer, this company is now rated as one of the largest suppliers of airplane sub-assemblies, supplying specified units to at least five aircraft plants. Also manufactured are airplane wheels and brakes, bullet-sealing fuel tanks for planes, rubber life-rafts, gas-masks, barrage balloons, semi-rigid airships for coast patrols, and so on.

Operating factories in seven foreign countries, and owning rubber plantations in the Netherland Indies, Philippine Islands, Panama, and Costa Rica, Goodyear has the heaviest foreign investment of any rubber company.

Firestone: Now reported to be the largest producer in the United States of metallic clips for machine-gun cartridges, this company is also manufacturing such non-rubber items as oxygen tanks, airplane wheels and brakes, and Bofors anti-aircraft gun mounts and carriages. Among rubber items being made are gas masks, life rafts, and tank track blocks. Tires, which ordinarily constitute 70 percent of Firestone's output, continue as one of its most important products.

Although Firestone operates factories in seven foreign countries, its most substantial investment outside the United States is in rubber plantations in Liberia, on the west coast of Africa. These areas have not yet felt the hand of war, and are considered to be highly valuable.

United States Rubber: Manufacturing nearly every product made of rubber and being the country's largest producer of non-tire rubber products, U. S. derives only slightly more than one half of its total sales in normal times from tires and tubes. Thus the non-tire rubber requirements occasioned by war are of material benefit to this company. Barrage balloons, bullet-sealing fuel tanks, and rubber life-rafts are some of the military products which U. S. is making.

Goodrich: Here is the one company of the five under discussion which has gone in heavily for development of the synthetic rubber field. At the same time, it has also broadened its operations in natural rubber. Credit is given to Goodrich for the endless rubber tread now being used on high-speed military scout cars, and for the de-icer for airplanes which operates by inflation and deflation of a rubber section on the leading edge of the wing. Also being made are balloon and airship cloth, bullet-sealing tanks, and military tires.

In the field of synthetic rubber, Goodrich is found to be part-owner, with Phillips Petroleum Company, of Hycar Chemical Corporation, the nation's largest producer of the petroleum-based synthetic, butadiene. Goodyear also makes the rubber-like synthetic known as Koroseal and, in 1940, put into commercial production automobile tires using the synthetic rubber called Ameripol.

General Tire and Rubber: Mainstay of this company's business always has been vehicular tires. But, some five years or so ago, there was opened a General plant for the manufacture of non-tire items. As a result, this mechanical goods division was ready to do its part in the war effort when required. Thus, the output of all types of tires is being supplemented by General's manufacture of barrage balloons, wind socks, gas masks, and molded airplane parts.

That's the way the rubber industry shapes up in the present war effort. Add to the above the fact that each and every one of these companies is managing one or more government-owned arsenals for the production of TNT, small arms ammunition, powder-bag loading, and so on, and it is evident that the rubber industry is doing at least its share in the present war. It is also obvious that it will come out of the war effort with a vastly increased amount of "know-how" that the rubber companies will be able to apply to their operations in the field of peace-time production.

STEEL IS PERFORMING

BEHIND the iron and steel that are playing such an important part in our war effort is an industry that has alternately been cursed and blessed throughout its existence, an industry that despite its size is sufficiently diversified and flexible as to have survived world-wide criticism and to have been ready for emergencies when they arose.

Critics would have us believe that the bigness of the steel industry, its financial strength and integrated management, its ability to control valuable processes, are all undesirable features that should be overcome. But let those same critics see how the steel industry is meeting the present requirements of economical operation, is making extensive savings in the use of precious alloying metals, is operating at virtually 100 percent capacity and, if they correctly interpret the trends, they will realize that the very features which they criticised most loudly are those features which are making it possible for the steel industry to contribute largely toward winning the war.

—The Editors

OUR *Point* OF VIEW

"GET TOUGH"

"IN WAR you cannot afford the luxury of squeamishness. Either you kill or capture, or you will be captured or killed." Not pretty but, unfortunately, factual to a ghastly degree for both armed forces and civilians in today's world. The quotation is from Captain W. E. Fairbairn, formerly of the Shanghai Military Police, lately instructor of the British Commandos, and now on loan to our own armed forces. The Captain's new book, "Get Tough," embodies his years of experience in the art of rough and ready self defense and offense with the hands as one's only weapons. It is not nice reading. It tells casually and coolly how to gouge, break an opponent's arm, leg, or neck—but, unpleasant as the subject matter may prove to many readers, its underlying philosophy is the only acceptable one for Americans who desire to continue "our way of life."

It's about time we did get tough In six months of war we have lost thousands of men, hundreds of ships, untold tonnages of food and war munitions—which, nevertheless, our taxes must pay for– to say nothing of the Philippines, Wake and Guam Islands, and portions of the Aleutians. We lost face with other nations, both friend and foe, and, worst of all, we lost some of our own self respect. What did we win? We won the battles of the Coral Sea and Midway Island and many smaller engagements, tactically important, but hardly compensatory with our losses

These comments have nothing to do with our armed forces. At Pearl Harbor, Wake, Bataan, Corregidor, on the seas, and in the air our fighting men have indelibly recorded *their* toughness in their own blood on the pages of history's newest tome. But what of the rest of us?

We were a tough people during the dark days of '76 and the long years that followed. We were tough in 1823, when a man in the White House spoke important words to all the world, words later called the Monroe Doctrine We got "that way" after the Alamo, when the battleship *Maine* was sunk; when a Kaiser and his henchmen torpedoed shiploads of our women and children—but are we that way now?

That fellow, Schickelgruber, and his pesky little yellow cousins in crime think we aren't. For their own sound reasons they do not question the hardihood of the boys in blue and khaki—but what of the rest of us? Are we tough enough? Do we realize that this Thing that is loose on our gory globe is so big, so strong, so ruthless that unless we in the United States all get tough—and soon—we may suffer the loss of many idealistic and realistic things, things that will make the present commodity shortages seem extremely picayune?—*A.D.R., W.*

WHAT'S AN AMATEUR?

THE amateur works because he cannot help it, impelled by a love of the work he does.

Today the amateur home mechanic is helping to win the war in at least three specific ways: as a "bits and pieces" machinist bending over a cellar lathe at home after regular working hours while the owls hoot outside; as a repairman reconditioning firearms for home-guard uses; and as a precision optician making parts of the optics of armament to fight Hitler.

All three of these amateur movements have been organized and are now in actual production. The results they have given are changing the meaning of the word amateur. What is an amateur?

The trouble with this two-headed word is that it means two different things that sometimes actually march in diametrically opposite directions. It means, first, a dilettante who makes a superficial pretense. But it also means a man who practices an art for the love of it. Now, when it turns out, as it is turning out more and more often, that the man who practices an art for the love of it equals, or even excels, the professional who works mainly to earn a livelihood and sees little romance in what he does, the word amateur comes to connote something not derogatory but entirely good

The program for home machinists has been described in other publications. Hundreds of lathes and other machine tools in cellar and attic shops have been put to work on bits and pieces of armament, their owners becoming sub-contractors.

The National Rifle Association has organized those of its members who are gunsmiths in a program for reconditioning old rifles of standard caliber. It also is endeavoring to round up for similar uses as many as possible of the old Springfield rifles which had been sold to private individuals and to put them to better uses than lying in attics.

Scientific American, since last autumn, has quietly organized in a program some of its thousands of amateur telescope makers. A limited number of these advanced workers have already demonstrated that the amateur who works mainly for the love of the work, or for the hate of Hitler's regime, can successfully do precision optical work of a grade of difficulty that is looked upon even by most professionals as ultra, and which some of them find it prudent not to tackle. Several of these amateurs now hold primary contracts, and some of them, if they continue to make good on the promise contained in their preliminary successes, will no doubt be able to expand their home shops into much larger plants

There is today far less tendency to look down the nose at the amateur than there was a generation ago, for the amateur has proved up in too many ways. The classic example of this proof was the help given in World War I by the American Radio Relay League, about which everyone has often heard. The War Department discovered that it had among those amateur "hams" a huge reservoir of virtual virtuosi in radio engineering. Since then it has been far easier for amateurs of any kind to get a straight-faced hearing, and today the professional who low-rates the amateur is likely to be warned by some other professional that he had "better look out, or that fellow you scorn will soon be catching up and blowing on the back of your neck."

There is no longer even any need for the amateur to over-compensate by being cocky and assertive. In most places he meets with an honestly co-operative reception and an intrigued interest in what he is trying to do. Sometimes the professional envies him, for the amateur hasn't had his fun spoiled by having to make a living from it.—*A.G.I.*

Housing on the Double Quick

Factory Production-Line Methods Applied to Speed Construction and to Conserve Building Materials

GEORGE MICHELSON
Vice President, J. Slotnik Company, Boston, Mass.

On a 600-unit housing development to accommodate personnel at a Navy Yard, practically the only tool the carpenters used in the field was a hammer. The explanation of this unusual operation was complete pre-cutting of all lumber, each piece being plainly marked when cut and stacked near the fabrication yard. When the foundations were ready, the lumber for the floor of one building was hauled to point of use, followed, as required, by all the framing lumber and then by plumbing, roofing, and electrical materials. Trim and interior finish came to the work cut to size and was completely assembled in a job fabricating shop. Erection utilized production-line methods, a crew doing only one operation on a house, then passing on to the next building.

Pre-cutting and assembly-line techniques were adopted by the contractors to conserve material and to meet an expected shortage of skilled help in an area where little construction had been done in the last ten years. This solution of the labor problem was based on the expectation that an unskilled man would become efficient quickly by working at the same job day after day.

Before ground was broken the contractor analyzed carefully the operations necessary for construction, and agreed on 22 essential operations for the construction of the one-family units with only one more operation necessary for the double units. The next step was to estimate the number of man-hours required to perform each operation and select proper size crews to keep each portion of the work "in step." Sufficient crews were then organized to insure the desired overall progress on the project.

Field supervisory forces consisted of a general superintendent to whom an assistant general superintendent, the expediter, and the office manager reported The assistant general superintendent held direct supervision over field engineers, inventory control of warehouse and mill, assistant superintendents in charge of subcontract work, and operation superintendents directly responsible for several team captains in charge of small groups on the various essentials of construction.

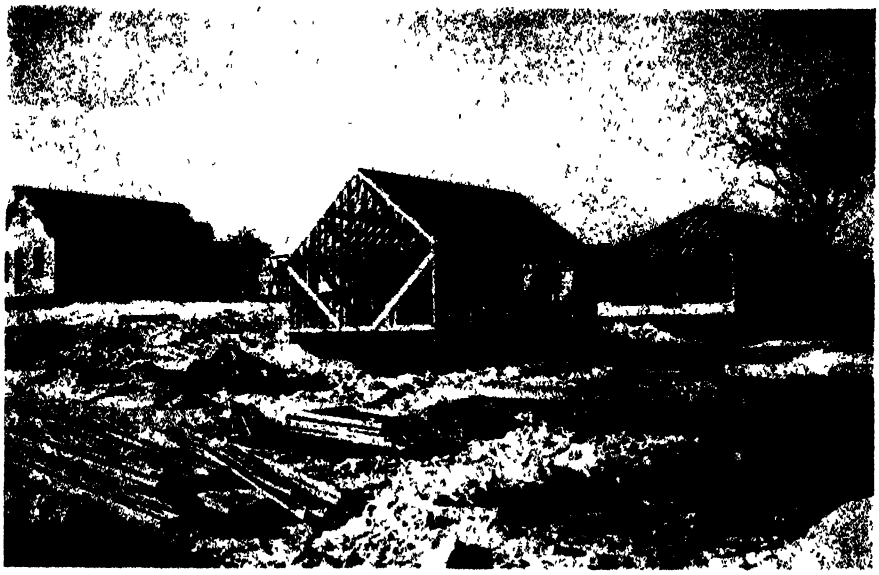
The 600 dwelling units of the development are made up of 150 single units, 24 feet, 4 inches, by 28 feet, and 225 two-family units, 24 feet, 4 inches, by 55 feet, 8 inches. Each family section has a living room, kitchen, two bedrooms, and bath. No basement is provided but full outside walls are carried below the frost line. A storage space 10 by 10 feet is floored in the attic with access through a 30 by 30 inch scuttle. Heat is oilfired hot air, the heating unit (located in a kitchen alcove) supplying year-'round hot water. Electricity is used for cooking and refrigeration.

Exterior walls are two- by four-inch studs at 16 inch centers with one inch wood sheathing, building paper, and creosoted wood shingles Roofs follow the same pattern as the walls but use composition shingles.

Interior walls are 3/8-inch thick fiber board nailed to the studs, no other wall insulation being used; the ceiling is the same material but has insulating batts laid between the ceiling joists: walls and ceilings are painted. Double houses have special soundproofing in the party wall, the insulating strips being zigzagged between studs facing each way to entirely break the connection between the units.

The supervisory men responsible to the assistant general superintendent were in charge of certain operations only, rather than over a particular area or group of blocks in which houses were being built. The contractor's plan of operations was to follow as nearly as possible the straight-line factory production methods except that the workmen move past the product in lieu of the product moving past the workmen. By organizing the work in this way, a minimum of non-working foremen were required. Within each group of men working on a particular operation was a team captain with two-fold duties. First, he was responsible for maintaining the rate of progress established for his "team"; secondly, it was his responsibility to his team to make certain that their materials were at hand. The exercise of these duties kept the teams alert and active. Each man, after an operation was started, quickly realized his importance to his team; a "ringer" posing as a carpenter was quickly routed out by his teammates to better their production rate.

A system of inventory control was set up to conserve material and prevent waste. The inventory control served not only this function but also alleviated the unskilled labor situation by supplying all possible parts ready to use, thus substituting routine operation for general craft skill. In order to carry this out successfully, it was



Rough framing of single and double units, and rough boarding of a single unit. In foreground are pre-assembled window frames and studs cut to length

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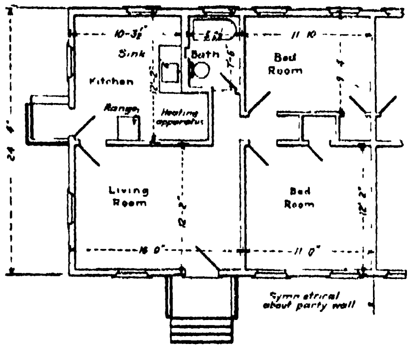
Courtesy "Engineering News-Record."

necessary that the proper amount of the materials required for each operation be made continuously available to the craftsmen. If workmen were obliged to look for a piece of lumber or were allowed to exercise choice in the use of lumber, this method of operation would have failed.

A carpenter shop 150 feet by 80 feet was set up for the purpose of milling the framing lumber and building up such sections of each house as it appeared could be economically prefabricated. The mill was made of adequate size so that when the milling operations were nearly completed, the mill could be transformed into a suitable shop for pre-cutting the wallboard and also for setting up door frames and hanging doors and installing hardware.

At the time that the engineering staff divided the job into the various operations, full-size details of every piece of lumber going into the house were prepared. This was carried out even to the preparation of blocking for plumbing fixtures. The next step was to determine which members could be economically built up and delivered to the house location ready for installation.

Trees were carefully protected during house construction, and every care was exercised in locating the homes to take advantage of the contours of the site



Floor plan of half of a two-unit house. Single-unit plan is similar, but with a bedroom window in what here is a party wall dividing the two dwellings

All the lumber was cut in advance and, where possible, partially assembled in the shop. Sills were cut for positions above and below windows and the short studs nailed to them in the proper length to fit in their marked position.

Incoming materials were received by a stock control supervisor who assigned them either to the warehouse or to the mill. Lumber assigned to the mill was placed upon gravity conveyors which fed two lines of radial-mounted circular saws. Each saw was set to make one cut, after which the piece passed on to the next saw. For a hip rafter the first cut was a double mitre on the front end of the piece, after which it was measured to a templet and marked for two straight bevel cuts on the opposite end and then passed to the next saws until all cuts were made. Each piece was marked to show its exact location in the finished work.

Excavation for water and sewer lines and for the outside walls of each house was carried to a depth of four feet. Truck-mixed concrete was used for an 18-inch wide, 12-inch deep footing under the exterior wall with 18-inch square footings for the interior columns. Bricklayers then placed concrete block walls and columns to the height required to accommodate the building to the existing ground.

The material for a complete floor system was collected on a truck at the storage yard and hauled to the building site and piled—not dumped—as close to the work as possible. (Skids and tractors were used during the spring thaw.) The exact number of pieces of lumber required were taken to the work and if one was broken it was returned to the yard for replacement or, if taken for other purposes, a special explanatory requisition was issued. Unsatisfactory lumber was culled during the operations carried out in the carpenter shop. Savings in waste, in rehandling of material, and in reduced confusion are believed to have compensated for the few trips necessary to the storage yard for replacement material.

Floor framing was started by laying stringers over the center piers, followed by floor joists set in place at 16-inch centers and lapped over the center stringer. Bridging, already cut for quick handling, was nailed in place, followed by the sub-flooring, not pre-cut, which was placed over the entire area; the edges were trimmed with a portable electric saw. Necessary openings through the floor were cut later by a special crew.

As soon as the floor was laid the framing for the rest of the structure was brought to the site and piled so that material required first for construction was on top. The walls were assembled on the completed floor, the previously sawed-to-length studs, and sills with short studs, expediting the operation.

FOLLOWING the same procedure there was delivered to each house the exact quantity of side wall and roof paper, asphalt roof shingles, creosoted wood shingles for side walls, including pre-cut wood shingles for gable rake, window frames, sash, and wallboard. Doors were fitted, hung, and hardware installed at the mill so that they were delivered as a complete package to each house and the field work involved merely the erection of the unit in the rough opening left in the framing. Some of these details are shown in the illustration on the opposite page.

Shipments of material from the warehouse or the lumber yard were made in accordance with definite schedules. Variations from the scheduled quantities were reported immediately, investigated, and rectified. Use of this method of controlling materials proved that building mechanics can be trained to follow schedules; that waste can be eliminated; that the cost of maintaining the inventory control system is much less expensive than the cost of waste; and that, at no extra expense, rubbish can be greatly reduced.

Star of 1054

Our Crab Nebula Proves to be a Guest-Star Strikingly Observed in China 900 Years Ago

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

In the western part of Taurus, due north of Orion, a fairly bright nebula was observed and catalogued by Messier. Later, some imaginative observer called it the "Crab Nebula." Its sponsor must have had as lively a capacity for seeing figures in the sky as blessed the ancients who named the constellations, for it is a somewhat irregular oval mass, which looks more like a potato than a crab—but the name has stuck to it, and is now generally used, at least in English.

By whatever name it is called, it is one of the most remarkable objects in the sky. It is of moderate size, about 6′ by 4′ in extent, and shows the familiar nebular bright lines -forbidden lines of oxygen and neon and ordinary lines of hydrogen and helium —all superposed on a faint continuous background. So far, there is nothing unusual, but Lampland, at the Lowell Observatory in 1921, comparing photographs taken at an interval of eight years, found that the nebula was in motion, and measures by Duncan at Mt. Wilson confirmed this

Later photographs by Duncan extend the interval of observation to nearly 30 years, and reveal the character of the motion clearly It is illustrated in our illustration (from Duncan's paper of 1939) The arrows show the observed displacements of each of the measured points, multiplied by 17, so as to get the motion in 500 years.

It is evident that the nebula is expanding in all directions, and at a very rapid rate, astronomically speaking. Carrying the observed lines of motion back, they all pass close to the point indicated by the white dot which has been inserted in the figure (There is no such thing in the nebula.) The small discrepancies in direction probably arise mainly from uncertainties of measurement of the nebulous condensations, which are not very sharply defined. Carrying the motion back in time as well as in space, it appears that all parts of the nebula started from this central point at nearly the same time, about 800 years ago—the discordances being again attributable to uncertainty in the measures.

This suggests almost irresistibly that the nebula owes its origin to some great outburst, about eight centuries ago, near the marked point, which ejected masses of gas in all directions, and with somewhat different velocities, whose persistent outward motion has resulted in the observed picture.

If some of these gas-masses were thrown out almost directly toward the Earth, or away from it, they would appear to move slowly, even if they were really moving as fast as the rest. This explains why the central part of the nebula is also bright.

A conclusive test of this interpretation may be made spectroscopically If the light of the central region really comes partly from gas on the front side of the expanding mass, moving toward us, and the rest from gas at the rear, moving away, the lines in the spectrum of the first should be shifted toward the violet, and those of the second toward the red, giving double lines-- somewhat like those in the spectrum of RW Tauri, described last month, but arising this time from motions straight out from the center, and not in a circle around it.

Double lines were observed in the spectrum of this nebula by Slipher at Flagstaff in 1913. Spectra adapted to accurate measurement, taken by Mayall at the Lick Observatory in 1936, showed that the velocity of the outward motion for points apparently near the center of the nebula was 1300 kilometers per second in each direction —falling off toward the edge of the nebula—as we might expect, since the motion of points in this region should be nearly crosswise to our line of sight. This makes it certain that the nebula **is really expanding. Assuming that the rate of motion is the same in all directions, its distance may be calculated. Duncan finds 1250 parsecs, or 4100 light-years. The greatest diameter of the nebula, as we now see it, comes out about six light-years.**

This is not the first known case of an expanding nebula. The gaseous envelope surrounding Nova Aquilae of 1918 (which is still faintly visible, and still expanding, at a uniform rate) was undoubtedly formed by ejection of matter from the star, literally under our eyes. Hence, as soon as the expansion of the Crab Nebula was discovered, the suggestion was obvious that it owed its existence to some similar outburst eight centuries or so ago. Since the Crab Nebula is still fairly bright, the catastrophe which produced it was probably of extraordinary magnitude and visible as a very bright Nova.

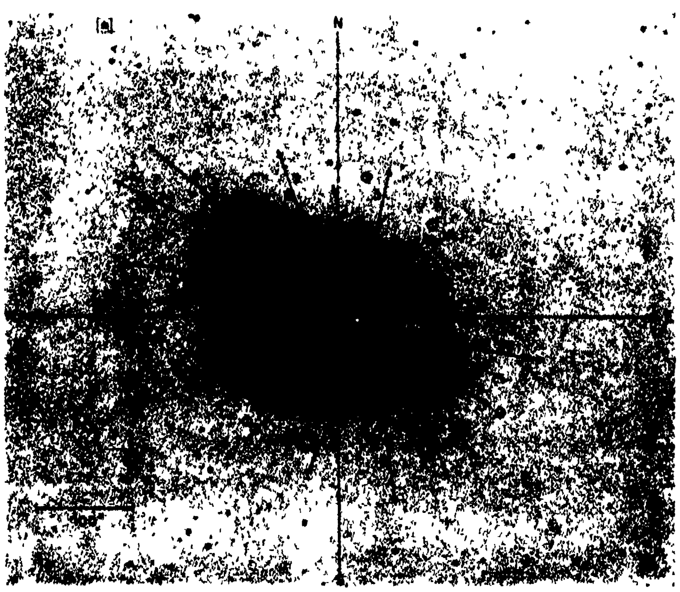
Lundmark, in 1921, pointed out that certain Chinese records described the appearance of a "guest-star" in the right part of Taurus, and in the year 1054 A.D.—translating the Chinese constellation and year into our familiar system. This is almost 900 years ago, instead of 800, but it would hardly strain the observations of the fuzzy moving nebular condensations to fit them to this slower rate of motion, and the hypothesis that the Crab Nebula was produced by the outburst of a new star seen in China in 1054 has ever since been regarded as probable. New evidence, just published, appears to settle the question in the affirmative.

Professor Duyvendak of the University of Leiden—a distinguished authority on matters Chinese—has discovered, in other ancient chronicles, several additional references to the "guest-star" which appeared in this year. For example, "In the first year of the period *Chih-ho*, the 5th moon, the day *chi-ch' ou* (July 4, 1054) a guest-star appeared several inches south-east of *T'ien-kuan* (ξ Tauri). After more than a year it gradually became invisible," and from another chronicle: "It was visible by day, like Venus; pointed rays shot out from it on all sides; the color was reddish-white. Altogether it was visible for 23 days." References to this object are also found in chronicles written in Peking, and in Japan. These detailed records were evidently due to the belief that the appearance of this strange star was a portent of things to come; but they preserve information of much scientific importance which has been discussed by Professor Oort, of Leiden.

and Dr. Mayall, of Lick Observatory.

The great brightness at maximum, combined with the known distance of the Crab Nebula, show that the "guest-star" of 1054 was a supernova of unusual brilliancy.

To be visible by day, like Venus, it must have had an apparent visual magnitude of about —4; but this is rough, for the Chinese had no way of estimating how much brighter than Venus it was. Even at this long interval, we may improve this rough value. The 23 days mentioned in the ancient chronicle evidently refer to the interval during which the star remained visible in the daytime. Now, three super-novae in distant extra-galactic nebulae have been well observed in recent years. Their light-curves were remarkably similar—the decline in brightness in 23 days after maximum being 1.3, 1.5, and 1.6 magnitudes. Hence it is reasonable to assume that at maximum the star of 1054 was 1.5 magnitudes brighter than when it was last seen in the morning after sunrise, by observers who had followed it through the dawn The limit of visibility under these conditions is about —3.5 magnitude, so that the supernova at maximum must have been near —5.



Courtesy "The Astrophysical Journal"

Arrows show the expansion of the Crab Nebula

The region of the Crab Nebula is affected by the absorption of light by the thin dust-haze which is widely present in the Galaxy, and causes distant stars to appear fainter and redder than they would otherwise look. From measures by Stebbins and his colleagues, of stars in the same region and at about the same distance, it appears that this absorption amounts to about one magnitude.

Had it not been present, the star of 1054 would have been at maximum of visual magnitude —6, and brighter than any other celestial object on record except a few comets With the distance of 1250 parsecs, this corresponds to an absolute magnitude of —16½, or to nearly 300,000,000 times the light of the Sun. This might put a strain on our belief, were it not that the brightest recently observed super-nova, which appeared in 1937 in the nebula I.C. 4182, had the well-determined absolute magnitude —16.6 —just a shade brighter.

Further evidence of the great brightness of the "guest-star" is found in the fact that, according to the Chinese records, it remained visible to the naked eye for some 650 days after its appearance. The super-nova in I.C. 4182 declined in brightness by 1½ magnitudes photographically in this interval. The visual change was somewhat less. Assuming the same for the earlier one, and that it was of the 6th magnitude when lost to sight, its maximum comes out at —5. This, by itself, is a rough value; but it shows that all the data are consistent with the belief that the ancient and modern super-novae were extremely similar. It is very remarkable that so much information is still available about an astronomical event which was visible nearly 900 years ago.

No direct evidence is available about the later history of either super-nova, for that of 1054 sank beyond the reach of the naked eye and that of 1937 beyond that of the 100-inch telescope, when the real brightness was, in each case, about 10,000 times that of the Sun. We can be sure, however, that the star which produced the Crab Nebula has not gone out. The emission spectra of gaseous nebulae can be accounted for only on the assumption that some very hot star, within or close to the nebula, floods the gas with ultra-violet light of very short wavelength, which, in rather complicated but well-understood ways, sets the atoms of gas to shining.

Almost at the center of the Crab Nebula is a very faint double star, with components of the 16th magnitude. One of these appears to be a normal star; the other is very probably the surviving remnant of the super-nova. In visual light, it is now about half as bright as the Sun. Its ultra-violet radiation must be enough to maintain the visible light of the nebula, and probably much other radiation invisible to us. It may then be concluded that it is still exceedingly hot—probably more than 100,000° even at its surface. Without "telling tales out of school" the writer may reveal that an interesting discussion of this subject is soon to be published by a Western astronomer.

Meanwhile, we may note that this nebula presents a very striking instance of the complications which arise in trying to apply our ordinary time-conceptions to objects at vast distances.

The "guest-star" appeared—to observers on earth—early in July, A.D. 1054; but the stupendous explosion which gave it birth actually happened about 3000 B.C. We see it now as it was in 2100 B.C. with an uncertainty of a few centuries affecting both figures in the same direction and to the same extent. It appears to us now as a gaseous cloud of six light-years in extreme diameter; but that was its size in 2100 B C. At present it must be almost 5½ times as big—if, indeed it is shining any longer.

We cannot yet say whether the initial star can keep up its extraordinary ultra-violet radiation indefinitely or whether it is still drawing on and slowly exhausting a store provided by the great cataclysm. Even if it has remained without change for the 4000 years and more that separate the star as we see it from the star as it is, the nebula must be much farther from the star, much more feebly illuminated and much fainter. If the star has cooled to an ordinary stellar temperature, the light which the nebula reflects must be much too faint to be observable.

What it is like now—or, more precisely, what it will look like to the observers of A.D. 6000—is for the present a secret, perhaps to be revealed soon by theory, but otherwise in the very safe keeping of light-waves which at the moment are neither here nor there, but are buried inaccessibly in that vast portion of space-time which Eddington, in one of his moments of inspiration, has called the Absolute Elsewhere.—*Princeton University Observatory, June 3, 1942.*

Our Search for the Supernatural

Dunninger Explains How Table-Turning, Once Explored by Faraday, May be Accomplished

"TABLE-TURNING. *Spiritualism.* Movements of tables, et cetera, attributed to the agency of spirits."—Webster's International Dictionary, Unabridged.

More comprehensively, and according to Lewis Spence, author of "An Encyclopedia of Occultism," table turning is a form of psychic phenomena in which a table is made to rotate, tilt, or raise completely off the ground by the mere contact of the operator's finger-tips, and without the conscious exercise of muscular force. The modus operandi is exceedingly simple. The sitters take their places around a table, on which they lightly rest their finger-tips, thereby forming a "chain," as it is known in psychic circles In a few moments the table begins to rotate, and may even move about the room, seemingly carrying the experimenters with it

This apparent phenomenon has been for years, and still is, in high favor among spiritistic mediums as an alleged means of communicating with the spiritual world. The alphabet is slowly repeated, or a pencil is run down the printed alphabet, and when the letter the spirits desire to indicate is reached, the table tilts. Thus have been "dictated" sermons, poems, "information" regarding the spirit world, answers to sitters' questions, and, who knows—perhaps at Berchtesgaden, even the Nazi war strategy.

Table turning originated in America, spread to Europe, reached England early in 1853, where it became immensely popular.

So prevalent did table turning become that men of science were urged to turn the light of scientific knowledge on the "phenomenon" and to endeavor to explain it on rational grounds. Foremost among distinguished investigators was the English scientist, Michael Faraday. By means of a simple apparatus of his own devising Faraday showed that the movements of the table were due to unconscious muscular action on the part of the sitters, who were thus, themselves, the automatic authors of the messages purporting to come from the spirit world. The conclusion drawn from Faraday's experiments was that when the sitters believed themselves to be either pressing downwards, or not pressing at all, they were actually pressing obliquely in the direction they expected the table to rotate—an expectation generated, possibly, by an advance statement, frequently on the part of the medium or leader, that the table would first move in such-and-such a direction.

Then, as now, not all agreed with the conclusions pointed to by scientific experiments. Two of the earliest investigators became satisfied the table was motivated by a force radiating from the operators, a force they termed "extenic force." Others were less rational in their explanatory attempts and the public, on the whole, was disinclined to accept Faraday's scientifically reached conclusion. People seemed to prefer the spiritistic explanations, or the pseudo-scientific theories which asserted that the "chain" of operators formed a sort of electric battery which supplied the table with vital energy, or, as it was then called, "electro-odyllic" force. Other explanations offered were odic force, galvanism, animal magnetism, and—strangest notion of all—the rotation of the earth.

Raduano tilts 10-ounce table

The apparent phenomenon of moving, tilting, or levitating a table remains as much as ever an argumentative question between those who subscribe to the tenets of spiritistic control and those who do not. On July 21, 1941, Signor Raduano appeared before the Scientific American Committee for the Investigation of Psychic Phenomena, and tilted—not levitated—a small table of his own, as well as one belonging to the Commodore Hotel.

The signor was given complete freedom to utilize powers which he prefers to term "psychic" rather than "supernatural" to tilt his tables, but his failure thus far to re-appear for simple tests before our Committee—in accordance with his own agreement—left no choice but to refer the matter to Chairman Dunninger for an explanation

In presenting our Chairman's views, it must be remembered that neither Dunninger nor the Committee maintains the following method was employed by Signor Raduano but until and unless the signor keeps his agreement to carry on his demonstrations under simple test conditions before the Committee, it will be accepted that this or some other mechanical device or means was utilized in Signor Raduano's table-turning exploit of July 21, 1941.

The three-legged table used by the signor was his own property. This was in accordance with our policy that "demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration." The signor's table was constructed of papier mache, or some other extremely light-weight substance. it weighed only 10 ounces, and was covered with a material resembling billiard-table-cloth in texture. Thus, the slightest friction between hands and table-top would tend to tilt the table. Whether or not the motion was accentuated by use of the right knee or the right foot cannot be factually stated, but one of the photographs taken at the time indicates that both these portions of the signor's body were in close proximity—if not in actual contact—with parts of the table. The hotel table, at the right in our photograph, weighed little more than the signor's special affair, and could likewise have been motivated by friction between its top and the palms of the hands. When a newspaper man was asked to place his hands on the outer, forward corners of the signor's table, and when the signor had succeeded in raising one table leg from the floor, the demonstrator removed his own hands, leaving the table poised on two legs, supported, apparently, by the palms of the newsman's hands The slightest pressure, even unconsciously applied by the reporter, would serve to maintain the poised position of the 10-ounce table.

This report, supplementing the one in our March 1942 issue, closes the Raduano case, unless the signor desires to re-appear before our Committee.

Ships Off the Line

Science and Ingenuity Help Produce Cargo Vessels for the Emergency—and for our Future Merchant Marine

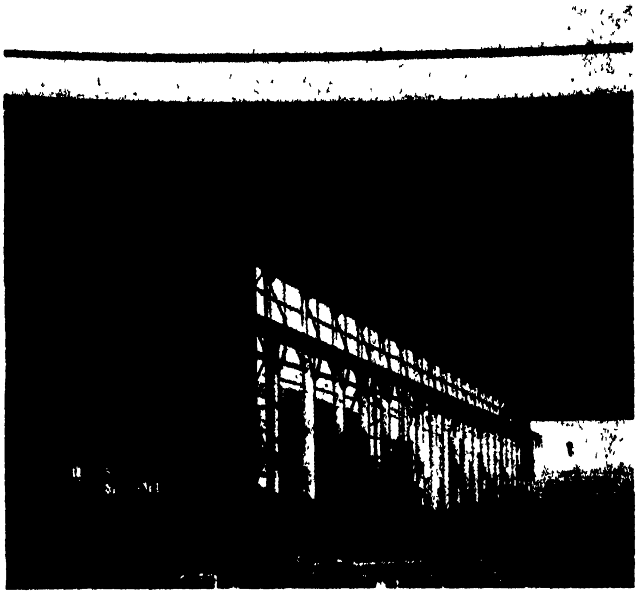
A. D. RATHBONE, IV

It's a long, thin room. It's filled—even in the daytime—with light-perforated dimness, the unending, clattering roar of giant rollers squeezing huge steel plates, the machine-gun staccato of riveters, and the hissing overtone of acetylene cutting and welding apparatus. This is an "assembly line" for production of Liberty ships, those 441-foot emergency cargo vessels that are now sliding off American shipways at the unprecedented rate of two a day—soon to become a near-miracle of three a day.

This third-of-a-mile-long room, 300 feet wide, is the fabrication plant at one of Bethlehem Steel Company's several shipbuilding yards. it's never quiet; and into the great maw, which is the receiving end of the building, are fed daily, from stock piles, enough steel plates to enable workers to cut, shape, and weld the 400 hull-plates necessary in the construction of one Liberty ship. There are 16 ways in this yard. Throughout the United States there are now 60 great shipyards aggregating more than 300 ways. Together they will produce and put into service 2300 ocean-going merchant ships by the end of 1943. Approximately 1500 will be the 7200 gross-ton Liberty vessels; slightly more than 300 will be tankers; most of the rest of the ships will be the modern C-types, destined to form the nucleus of America's great post-war merchant marine Some idea of our present merchant shipbuilding program may be had by comparison with similar efforts in World War I. The present plan is nearly twice as big in its five-year scope from 1939 to 1943 as was that of the other war in a seven-year period —2486 ships aggregating more than 25 million deadweight tons, against 1911 ships during the last war totaling over 13 million deadweight tons.

Why is it necessary for us to set up such a stupendous plan—a plan that will demand every ounce of energy for its accomplishment? There are several very sound answers

The battle fronts of today are in every far-flung corner of the world, and requirements of our war-production and delivery set-up must, therefore, depend on maritime commerce on a much vaster scale than ever before. Secondly, last time we had the use of cargo carriers from France, Italy, Japan, and other nations. It's different this time. Add to these the deplorable condition of the shipbuilding industry and our merchant marine before hostilities broke out. Shipbuilding had fallen to its lowest level of production when the United States Maritime Commission was brought into existence by the Merchant Marine Act of 1936. Then we had but 10 shipyards, with only 46 ways capable of producing 400-foot ocean-going vessels—and half of those were occupied with naval construction Significant, too, is the fact that between 1922 and 1937 American shipyards produced but two ocean-going cargo vessels, other than tankers and liners



Courtesy "Marine Engineering and Shipping News"

"It's a long, thin room, dimly lit . . . "

● THIS IS A WAR OF SHIPS . . . . Rear Admiral Emory S. Land, Chairman, United States Maritime Commission, stated in the April issue of "Marine Engineering and Shipping News" that: "This is a war of ships! American shipbuilders and shipworkers hold the destiny and freedom of the nation in their hands.

"Every hour lost in building a ship—no matter how it is lost—every work stoppage or slowdown—no matter why—is repudiation of that responsibility. . . .

"Ships built in time are truly Liberty ships.

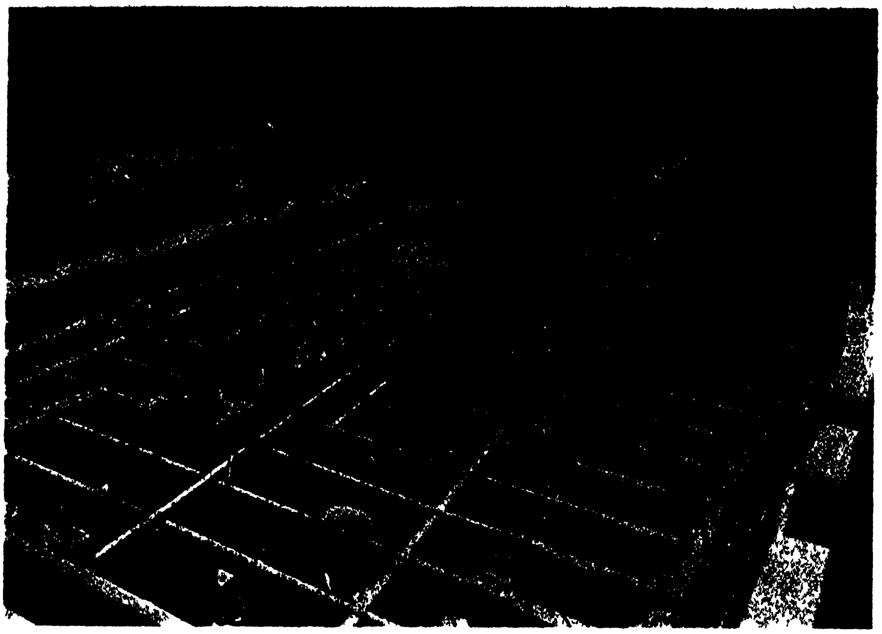
"Too late, they will be slave galleys for Americans.

"The men who build ships and the men who command them cannot fail America Knowing them as I do, I am confident they will not fail." ●

A primary purpose for the establishment of the Maritime Commission in 1937 was to devise plans for construction of new merchant ships to replace worn, obsolete, American merchant marine ships, virtually all of which had been constructed prior to 1922 Late in 1937 the Maritime Commission proposed to construct 50 ships a year over a 10-year period. From that modest beginning there has been a constant mushrooming of the program to the point where American shipbuilders now *must* produce an average of a little more than three ocean-going ships a day to meet the war needs.

The original annual quota of 50 ships was doubled when Hitler set fire to the world, it was doubled again in 1940, and, in January, 1941, the yearly goal was set at 400. However, not only were the existing shipyards—then 18, with 70 ways—incapable of producing more ships than already were scheduled, but the limited capacity for production of turbines and gears, the most modern propulsion machinery for the C-types of vessels originally developed by the Maritime Commission, had been fully absorbed by the then-existing program. That condition brought the Liberty ship—Emergency Cargo Vessel—into existence The maritime Commission was forced to adopt specifications for a ship propelled by reciprocating steam engines, a vessel not comparable to the already-approved Maritime Commission designs which called for the finest, most efficient, and swiftest merchant ships ever built—but, Liberties could be built faster, ever faster!

Never before had the shipbuilding industry of any nation been called up-



"Build more ships faster to win the war," says Rear Admiral Emory S. Land

on to utilize the ingenuity and efficiency necessary to produce 10,000-ton cargo ships in so short a time. Handicapped by lack of ways and yards, lack of steel, and a serious shortage of skilled workers and experienced supervisory ability, America's Maritime Commission and cargo vessel makers literally and figuratively rolled up their sleeves and went to work. They took a most important leaf from the automobile manufacturers' book—assembly-line and mass-production methods—and altered it to fit their needs. "Standardization" was the watchword. The Maritime Commission became the purchasing agent for everything that goes into the Liberty ships—from steel plates and engines to galley equipment and table linen, from windlasses and fuel-oil heaters to radios and gate valves. This ever-growing stream of thousands of items is retained in the Commission's central pool and consigned to the 60 yards as required.

A spread-the-work program has placed orders for ships' parts with 500 large and small plants in 32 states. Everything is uniform, so that no matter who makes it, it will fit in any Liberty ship. Worker training schools, under Maritime Commission authorization, are bringing out thousands of new skilled workers each month. Today, more than a million are employed in our American shipyards. Pre-fabrication of many parts, as well as pre-assembly of units, was successfully accomplished. Specifications were simplified to save time and essential materials. Welding took the place of riveting—Liberties are 85-percent welded. More ways and more yards were built, almost overnight, and all were laid out, so far as possible, to permit straight-line production. Schedules were expedited from the originally contemplated six months for one ship to 105 days, with greater speed-ups still to come. All this took place during a feverish 1941.

Then came Pearl Harbor.

One month later President Roosevelt called for an expansion of this already huge program by another 50 percent, and a later directive brought the goal to 2300 ocean-going merchant ships by the end of 1943.

Let's go back to that long, thin, dimly-lit room and see what manner of miracle is making this biggest ship-building program of all time click so well.

The first step is to unload the steel at the railroad siding. The storage yard beside this Bethlehem plant—only one of many, remember—receives 6000 tons a week, and on one day recently 127 cars of steel arrived. Enormous steel plates are carried by crane and flat-car into the pre-fabricating plant, where they are cut and formed. Much of the cutting is done by an instrument called a Travograph, in which four oxyacetylene cutting tips simultaneously slice four identical shapes from 5/16-inch steel plates with extreme and continuous accuracy. In this shop two of these multiple cutters, working full time, cut enough storage tank pieces—and they are legion—to supply all ships produced by this yard. In Travograph cutting, as in all such steel cutting, or "burning," for ships' parts, templates or molds, previously constructed in the mold-loft to full size of the ships' sections, are used to insure accuracy. Measuring lines, identification marks, rivet holes, welding spots are copied from template to each plate or piece so that later workers will know what they have and where it goes.

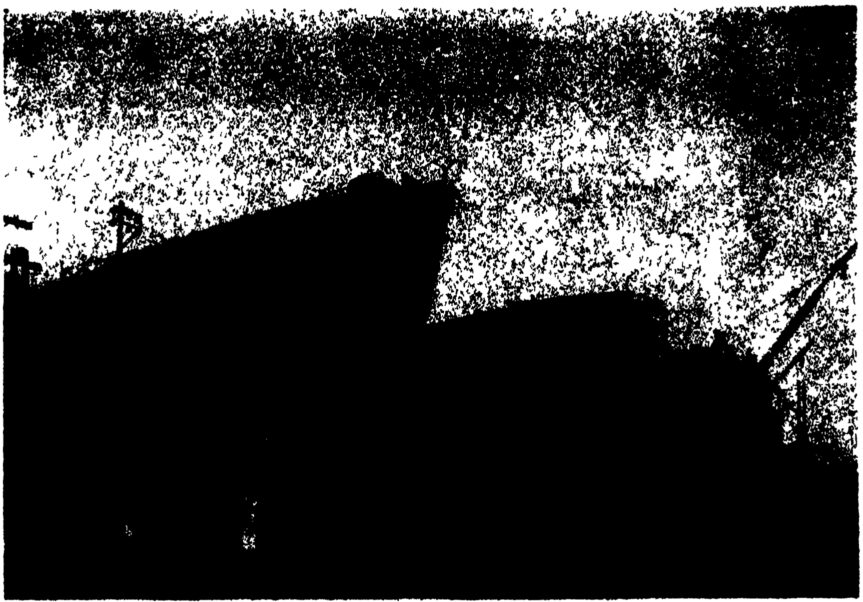
Farther along this 1380-foot assembly line the welders get in their work. As an indication of the extent to which arc-welding is used as the method of fabricating steel work one of the nations' larger shipyards has installed enough welding equipment in an open-air assembly line to keep over 3000 men busy operating more than 1000 welding arcs 24 hours a day—and that's only one shipyard! Frames, deck sections, bulkheads, bow assemblies, and other parts are formed and fabricated. Someone estimated that approximately 35 miles of arc-welded joints are made by manual operation and more than 7½ miles by automatic operation in each Liberty ship. On railroad flat-cars these sections are delivered to the ways, where keels have been laid and hulls are beginning to take shape.

With a precision that amazes the layman, the myriad parts unerringly find their way to their pre-destined locations. This is the job of the erectors and shipfitters, who can read and understand the weird hieroglyphics painted on the parts and assemblies. A small army of reamers, drillers, riveters, chippers, "burners," and welders swarm over the hull in what may seem the height of confusion, but in reality the co-ordination of plans, material, and labor in American shipyards is maintained on an exacting scale, as proved by the reduction in construction time from the prescribed 105 days to three months in many instances, and recently a Liberty ship came off its ways 46 days after

The welder is vastly important in the construction of our Liberty ship fleet the keel of the ship had been laid.

When decks and hatchways have been installed, the ship is launched—still an imposing spectacle, even though more commonplace these days. The ship moored to outfitting piers, welders, electricians, steam-fitters, and other artisans complete their particular installations. Altogether, some 500,000 man-hours are needed to produce one Liberty ship, and with increasing rapidity they are leaving their outfitting piers for their rigid test runs; but this speed-up of building in no sense implies sacrifice of ability or sea-worthiness. Rather, it is another reflection of Yankee ingenuity and abilities. While Diesels are not available at present to power these Liberty ships, it will be possible to replace present propulsion machinery after the emergency is over with Diesels, or with turbines and gears, thus making them into faster and even more efficient carriers

From high above on the scaffolding, a Liberty ship has skeletonized form



Courtesy "Marine Engineering and Shipping News"

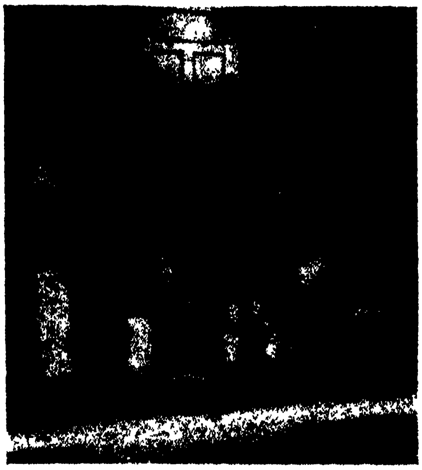
A keel is laid, the hull begins to form, and pre-fabricated sections are placed

All along the line the Maritime Commission's central pool of supplies has functioned in providing material and parts with which to build a ship, get it into the water, get it completely outfitted, get it ready for occupancy and for cargo service. Now, with test run over, the ship okayed for immediate use, the Commission makes its last move before actual service Every single item is checked into its place. The larder is stocked, the pots and pans are in the galley, fuel tanks are full of oil, the furniture in officers' and crews' quarters is in place and in perfect order, water tanks are filled—nothing is lacking now but a crew, a cargo, and a destination.

Across the bay from the shipyards are great wharves and warehouses, filled to capacity with the manifold munitions of war. There, too, await the highly trained and doughty seamen of the American Merchant Marine. After the Maritime Commission's final inspection and acceptance of the ship at the fitting-out pier, the newest Liberty steams across the bay to those docks, in charge of a temporary crew. Her captain and his men take her over, her holds are packed with every ton of war freight they can stand, and she is off to brave the Axis-born dangers of war-time shipping. Through cargo transportation she will do her share to make the Seven Seas once again the safe world highways of commerce they must be for a new and greater American Merchant Marine.

It is significant that even during the stress of war, American ship operators are retained to a great degree in their normal industrial function. Although the War Shipping Administration has taken control of merchant ships, the title to most of them remains with the owners, who continue to supervise their operation as direct agents of the Government. This policy of the Maritime Commission and the War Shipping Administration is indicative of the fact that war has not caused the abandonment of the primary objective of the Maritime Commission. If our merchant vessels survive the ravages of enemy action, war will have served as a medium for expediting our original Merchant Marine restoration program. And, with ship operators retaining identities in the present maritime structure, they may, without serious dislocation, resume their previous status when peace comes.

It seems clearly apparent that this nation will be called upon for years to come to provide the bulk of the ships and the sailors which will be necessary to restore economic balance and stability to this war-shattered world. Never again should we allow our shipyards to be disassembled. Never again should we permit our merchant fleet to reach the low level of efficiency and competitive ability which it attained in the post-war years following 1918 With present capacity at our command, we *can* maintain the 1943 rate of production of 15 million deadweight tons —and even increase it—if future developments show needs for additional tonnage.



Courtesy "Marine Engineering and Shipping News"

Larders are stocked—"soup to nuts"

East-Coast Cattle Ranching

A Vital Industry Gains New Life Through Scientific Development of Pasturage and of High-Quality Stock

HAMILTON M. WRIGHT

With wartime needs putting the demand for beef at an all-time high, the 1942 slaughter of livestock in the United States is expected to include 28,000,000 head of cattle and calves, according to Secretary of Agriculture Claude S. Wickard Thus, the progress of the beef-cattle industry in Florida and the neighboring tidewater states of Georgia, the Carolinas, and Virginia, creating a new cattle country in the South Atlantic Seaboard, is beginning to assume an important place in the nation's economy Florida's 1942 cattle population is already estimated at 1,500,000 head by Florida state authorities, but they say that Florida alone, with an estimated 25,000,000 acres of range land available for pasture improvement with newly introduced grasses, will eventually support a tremendous increase in this number.

This prediction is understandable in view of a statement by an experienced cattleman, who has raised beef cattle upon a large scale both in Wyoming and Florida, that he can raise a steer at an over-all cost of three dollars a year on the Florida range, as compared with 15 dollars a year in Wyoming where cold weather makes prolonged winter feeding necessary.

However, as recently as 1923 the most chronic optimist would not have dared to predict prosperity for Florida cattle. From a low ebb at that period, brought about by the ravages of the fever tick, beef cattle in Florida have undergone a phenomenal change. With the practical eradication of this dangerous pest since then, thousands of pure-bred beef bulls, including Herefords, Black Angus, the huge Guzerat Brahma, and other superior beef types have been crossed and recrossed on the native scrub cows, descendants of Spanish stock first brought to Florida in the 16th Century, to produce a preponderance of first-rate beef cattle.

In Georgia and North and South Carolina, where ten years ago a prime beef steer was the exception, thousands of acres of land withdrawn from the cultivation of cotton and tobacco by Government order are rapidly being converted to improved pastures or to winter cover crops, including small grains and legumes, to provide feed for large numbers of sleek cattle.

Herefords at home on a Florida range

Centered in Florida, the industry has swept swiftly up the Atlantic coast. Moss-hung plantations between Savannah, Georgia, and Charleston, South Carolina, where rice, indigo, and cotton once supported lordly establishments, have been transformed into cattle ranches Visitors last fall to the famous old Combahee Plantation at Whitehall, South Carolina, about 60 miles below Charleston, witnessed the auction of 500 baby beef steers, the largest sale of its kind in that part of the country to date. Almost two score of fat stock shows, where prime beef animals are exhibited for prizes and sold to highest bidders, have been held in Georgia and the Carolinas this past Spring. Many of these animals are used to breed improved stock and some have supplied beef to army camps.

What has caused the tremendous development of the cattle industry in the Southeast? The answer is, necessarily, not brief. The relatively mild climate for all, or a larger part, of the year, the availability of land for pasturage, good transportation, proximity of markets, all have contributed to make beef cattle a profitable venture in the Southeast. Yet one must look beyond these propitious factors, important though they are. Cattlemen from Arcadia, Florida, to Rocky Mount, North Carolina, will tell you that without the collaboration of science the cattle industry in the Southeast could never have advanced.

Truly, scientific achievement has effectively shown the way to conquer at least three outstanding obstacles which, beyond the memory of the oldest stockmen in the Southeast, had barred progress in cattle raising. These are, first, the cattle fever tick; second, lack of quality cattle; third, lack of improved pasturage and forage.

In the short space of two decades, men of science have contributed enormously to the solution of these problems. The scope of their cumulative effort can well be imagined, when it is considered that not only animal husbandry experts, including nutritionists, but plant pathologists, agronomists, mycologists, bio-chemists, bacteriologists, and, not the least, far-sighted cattlemen, often volunteers for co-operative research, have led the frontal attack. Contributing, also, is the enterprise of the County Agricultural Agents and other representatives of the United States Department of Agriculture, the extension services and experimental stations of the state agricultural colleges, and the livestock and agricultural experts of the railroads. These agencies have been and still are a potent force in educating the rank and file of stock-raisers as to how they can best benefit from the constantly expanding work of the scientists.

All-out efforts to eliminate the fever tick had begun in the Carolinas in 1917-1918 and in Florida several years later The native cattle of Florida had developed some resistance to the ravages of the tick through constant infection, though it was not unusual for a cattleman to lose from 10 to 15 percent of his herd in late winter and early spring in areas where natural

All photographs courtesy Atlantic Coast Line Railroad

Powerful tractors drawing heavy water-weighted cylinders armed with eight-inch knives are used to knock down palmetto growth and to reduce it to matchwood. Ground so cleared is planted with grass that has proved its all-around value as cattle feed

pasture was at its worst at that time of year. Moreover, they were tough, stringy animals, of slight commercial value. Good beef animals, when imported, promptly died of fever. One of the biggest cattle ranches, containing 99,000 acres, near Arcadia, lost an entire herd of imported Hereford bulls, worth $7500, in a single summer from fever tick infection. Leading cattlemen, with the assistance of Government and state officials, organized a concentrated drive to eliminate this destructive cattle pest. Corrals, chutes, and "dips" were created throughout the cattle regions, and the stock was dipped in tick-destroying solutions.

Tick eradication also started fencing, which made the animals easier to get at and prevented infected animals from mixing with those that were tick-free. At the present time no less than 12,500,000 acres of range land in Florida are under fence.

With the practical elimination of the fever tick from the Florida ranges, pure-bred beef bulls began to pour into the state. They were crossed with the already acclimatized native cows and the progeny again and again mated to imported stock. The imported blood most widespread now in Florida livestock is that of the Brahma, sacred cow of India, which can stand heat because it sweats like a horse, and which can go far for water and feed. But the white-faced Hereford is also seen everywhere, and the state is now firmly established as a producer of fine beef cattle.

The third step in the creation of Florida as a scientifically operated cow country is the sowing or sodding of nutritious, introduced grasses in place of native grasses. Native grasses provide satisfactory seasonal grazing only; the native wire grass, for example, is liked by cattle only for two and a half to three months, after which it becomes tough, unpalatable. Improved grasses afford exceptional pasturage for eight or nine months or more of the year. Some of these improved pastures, in fact, will feed a steer all the year 'round. One of the biggest ranchers in south Florida winter-fattens his stock on para grass pastures. Cattle like the introduced grasses better than the native. They fatten on them quicker and do not wander so much.

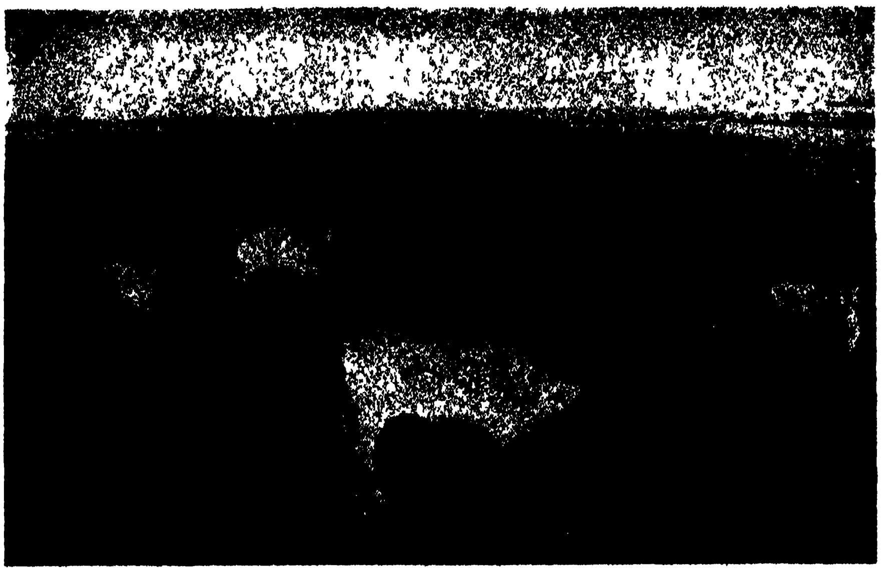
Of Florida's 25,000,000 acres of cattle range, 3,000,000 acres so far have already been partially improved as pasture. This land requires only continued work upon it to be rated as fully improved, capable of supporting several times the number of cattle that now graze upon it. In addition, there is much land to which carpet grass (*Axonopus compressus*), which is now almost a native of our southern states, has spread.

A dynamic change in Florida's progress as a cattle state came in 1936. At that time Florida cattlemen began large-scale planting of improved pasture with the financial aid of the Agricultural Adjustment Administration. Between the close of 1936 and January 1, 1942, 360,000 acres of improved pasture were put in with the aid of the AAA. Florida is now proceeding at an even faster pace, last year, cattlemen in that state put in 156,000 acres in improved pasture, with government aid.

An historic firm of Florida cattlemen, packers, and ship-owners are now operating two huge palmetto choppers on a day and night basis, clearing the ground of heavy palmetto growths for the sowing of pasture grass in the flatlands northwest of Lake Okeechobee in southern Florida. These machines comprise rotating steel drums, each weighted with 500 gallons of water and armed with eight-inch steel knives that reduce entire palmetto trees and the heaviest kind of shoulder-high palmetto brush to an appearance of chopped matchwood. They are drawn by Diesel Caterpillar tractors, each making a speed of four miles an hour. Each machine clears an acre an hour. The combined clearance of the two machines is, therefore, almost 50 acres a day. When the land has been cleared of palmettos, carpet grass is disked-in to start the pasture. The entire destruction of the palmettoes requires two additional applications of cutters, one year apart.

This sort of land clearance is going on all over the palmetto regions in the Florida cattle ranges. Within three months of disking-in the carpet grass, cattle are grazing on the new pasture. However, carpet grass requires three years to become firmly established, and it is helped by close cropping.

Far to the North, yet within the Coastal cattle belt, which extends more than one thousand miles North and South, near Wilmington, North Carolina, a famous agriculturist and stockman has developed a continuous grazing program for his dairy herd, by a scientific rotation of small grains, feed crops, legumes, and grasses. Eleven different crops are involved. This permits his cows to graze the year 'round in the open on rich, succulent green feed, and must be regarded as an im-



Above: The imported blood of the famous Brahma cattle strain is evident in this herd of Florida cattle. Brahmas (a pure-bred bull is shown below) are notable for their ability to withstand great heat

portant contribution to the livestock industry in the South. This plan, like others, which makes the animals do the work of harvesting in winter, is one of the factors that makes cattle raising in the Southeast so profitable. In this connection it should be pointed out, however, that the program represents a highly perfected grazing plan and that the majority of beef and dairy stockmen in the Southeast limit themselves to five or even as few as two crops on the list, although some cattlemen, farther South, carry their cattle successfully on improved pasture through the year.

A favorite grass in south Florida is the para grass *(Panicum purpurascens* or *Panicum barbinode)*, well known in south Florida and originally introduced from Brazil, used both as pasturage and also in silage in the winter feeding of cattle. This grass, a very fast grower, has been known to yield 30 tons to the acre under favorable conditions. The density of this crop can be inferred when it is considered that there are 43,560 square feet in an acre, and that to attain this result each square foot must average a production of more than one and one-third pounds of the grass. This grass has creeping stems sometimes as long as 30 feet and as large as a lead pencil. It takes roots at the joints and makes an upright growth of three to five feet. It has a tendency to choke itself by its thick root growth and must be disked before it is killed out by its own excessive vigor.

Among other grasses, especially developed for beef cattle in Florida, are Napier or elephant grass, which attains a height of six feet, and a new cold- and wilt-resistant selection of Bahia grass. The selection of Napier grass, evolved by the agronomy department of the University of Florida College of Agriculture, represents but one of more than 4000 specimens of this variety of grass studied that would best meet cattle forage requirements in Florida. A new type of Bahia grass that is more cold-resistant and a better seeder than common Bahia, a native of Paraguay, has been developed by the United States Everglades Experiment Station. The painstaking selection process, often requiring at least five years of experimentation before the grass is released to stockmen, is just one of the methods employed in evolving improved grasses for the Southeastern cattle industry.

At Moore Haven, west of Lake Okeechobee in southern Florida, one cattle buyer during the past winter secured fine results with winter feeding of cattle for the market by using in silage 15 tons of black strap molasses to each 320 tons of para grass cut green. But now that molasses is getting scarce, it is proposed to use the residue from the citrus canning plants in a similar manner. Already, some 35,000 tons of dried citrus-pulp are being used as cattle feed per annum.

Florida and its sister tidewater states have undeniable natural advantages for cattle raising. Mild climate and plenty of rainfall permit continuous grazing for nine months in the year in certain parts of this territory and already for a full 12 months in other sections. Excluding transportation facilities and proximity to markets, in both of which the Tidewater States occupy an enviable advantage, the low cost of feeding cattle is the Circean lure that is proving irresistible to experienced cattle investors from other parts of the country.

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LAWNS

Grow Best When Planted In the Fall

There has been considerable controversy in the past as to the best seeding time for lawns, but it is now generally conceded that Fall is by far the best, according to a statement made by J. W. Lentz, Director, Scott's Advisory Lawn Service. In spite of this, Mr. Lentz estimates that about 70 percent of home lawn growers still defer seeding until spring; he stressed, in a recent interview, that spring grass seedlings are apt to perish with the advent of hot, dry summer weather.

Early September seeding is ideal, since the grass then has a good start before freezing weather. Even seeding done in winter months results in better lawns than when sowing is deferred until spring, for the seed will germinate during the early days of spring when the soil would usually be too soggy to work.

FINGERPRINT

Classifiers Wanted In War Jobs

Fingerprint classifiers will be appointed in Government service through an examination announced recently by the United States Civil Service Commission. The Bureau of Navigation in the Navy Department, the War Department, and other Federal agencies in Washington may make appointments. The salary is $1620 a year. There are no age limits. Since the last announcement for classifiers made by the Commission, the experience requirements have been reduced, and the field has been broadened to include members of fingerprint clubs or other organizations who have had training in the Henry system of fingerprint classification.

Instruction in the Henry system, and, in addition, three months of appropriate experience in that system, may qualify applicants. Their experience may have been in Federal, State, or municipal bureaus, in the employ of private corporations or individuals, or in fingerprint clubs under professional supervision. Proof of experience must be submitted Perfect vision is necessary. The written test will be a practical one on the identification of basic fingerprint patterns and classification under the Henry system.

Applications must be sent to the Civil Service Commission, Washington, D. C., and will be accepted until the needs of the service have been met The forms for applying may be obtained at first- and second-class post offices throughout the country, or direct from the Commission

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PAPER—Wood pulp (wholly or in part) is the source of nine-tenths of American paper.

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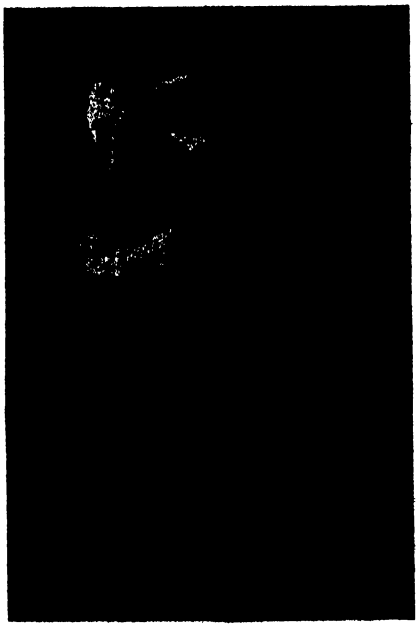
ASBESTOS SUIT

Designed for Rapid Use, Complete Protection

A NEW one-piece asbestos protective suit, which provides instant and complete personal protection against flame hazards in emergencies, consists of an upper-and-lower durable asbestos garment securely sewed together, with helmet, gloves, and boots attached to completely enclose and protect the wearer. The unit prevents the entry of flame, insulates against heat, guards the head from injury by falling or flying material, and enables speedy and effective work at the scene of emergency.



Flames can't enter

The helmet of the suit is made of laminated Bakelite, asbestos covered, and with front and rear aprons to protect the head and neck. A large window of heat-resistant glass in the hood permits unobstructed vision.

Quick access to the suit, made by the Mine Safety Appliances Company, is provided by a zipper opening extending down the front from neck to waist line. When closed, the zipper is protected by a flap held in place by two arctic buckles Zipper fasteners at the wrist and lower sections of outside leg seams facilitate rapid donning of the suit. Wrists, ankles, gloves, and neck portion are flannel-lined for comfort Sole and heel of boots are reinforced with asbestos brake lining material, riveted in place for durability, long wear, and protection.

The suit is made in a universal size only, with tabs at each side and back to adjust length.

PHOSPHORESCENT

Material in Sheet Form For Blackouts

A FABRIC sheet with a phosphorescent coating on one side is now available in rolls under the name Conti-Glo P-10. The material can be cut from its sheet form into strips and used to outline objects and obstructions so that they can be seen in the dark. For example, long strips may be applied to the side of a stairway or along the wall of a room. Shorter strips may be used on the stair risers.

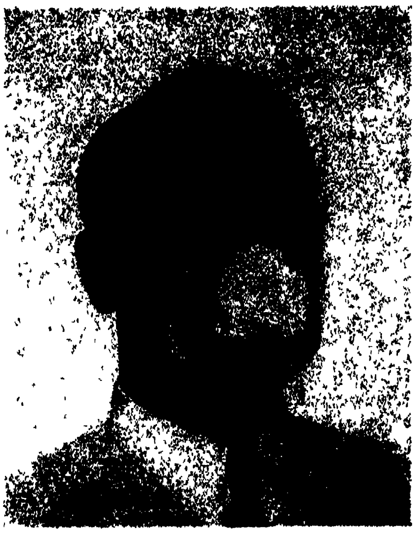
The material resembles oilcloth in appearance and can be secured to any surface by tacking, by the use of adhesive tape, or by cementing in place.

RESPIRATOR

Keeps Out Dust, Can be Used with Inhalant

WEIGHING only half an ounce with its filter pad in place, a new respirator is useful in industry as well as in the treatment of certain respiratory ailments.

This respirator, announced by Allergy and Medical Products, Inc., and shown in one of our illustrations, is reported to be very comfortable to wear. This is due to its light weight, plus the fact that the frame of the mask is composed of a thin sheet of metal which can be molded to the contour of the face and which is held in place by an adjustable head band.



Weighs little, has many uses

A wire frame, attached to the bottom of the mask, holds the replaceable filter pads away from the nose and mouth, thus giving a large breathing area.

For ordinary use where it is desired to keep dust from the respiratory tract, plain untreated filter pads are employed.

For treating colds and other respiratory infections, a few drops of an effective inhalant are dropped on the filter pad, enabling the patient to bathe his membranes continuously with the soothing vapors.

STORED CARS

Need Complete Protection Against Deterioration

"UNLESS you are prepared to take the necessary precautions, it may be thriftier to drive your car sparingly than to put it in storage for the duration," says T H Stambaugh, director of national service operations for the Hudson Motor Car Company, and continues:

"If a car is stored for a year or two without precautions, it is doubtful if it can be put back in operation without a major repair job In addition, the owner is likely to find that his tires have deteriorated, the battery is ruined, and the car's finish is damaged.

"I have no quarrel with—in fact, I commend—those individuals who want to store their cars for patriotic reasons. Nor will I argue about possible savings in gasoline and oil if cars are taken off the road. However, preservation is one thing and waste is another. To preserve, we will have to go the full way through preparation to make preservation a practical thing and not just a theory.

"Persons who are considering storing their cars for the duration to save tires should consider the fact that tires deteriorate when not in use. This is because normal operation of a car flexes the rubber and keeps it alive. Light—even artificial light—damages stored tires. All windows in the storage place should be blacked out and the car should be blocked up to remove the weight from the tires. Even then, there should be a certain amount of inflation during the storage period, calling for periodic checking.

"When a car is placed in storage, all gasoline must be drained and then a half pint of mineral spirits, naphtha, or benzine must be run through the pump, carburetor, and engine to remove every last vestige of gasoline. If this is not done, gum accumulates, and the valves may stick so tightly that they may have to be literally 'hammered loose' from the guides.

"Before this is done, the oil in the engine should be changed to a very high grade product and the engine run for 5 minutes Then 2 ounces of a high grade No. 10 motor oil should be injected in each spark plug hole and the engine turned over several times with the starter, so that rings and cylinder walls will be thoroughly covered with a protective coating. Failure to take this precaution may mean that when the engine is started after a long period of storage the rings may be 'frozen' in the cylinders, and great damage could be done the engine when attempts were made to start it after the storage period is over

"The radiator should not be drained, because moisture remaining in the cooling system could start rust formations. The cooling system should be kept up to full level at all times. A rust inhibitor should be added to the coolant and if there is danger of freezing temperatures, anti-freeze should be added.

"To prevent rusting, springs, frame parts, clevises, and other chassis parts should be sprayed with motor oil. All bright finished parts must be treated with paraffin wax after rust spots, if any, have been removed

"To prevent deterioration of the lacquer, the car finish should be thoroughly washed, cleaned, and waxed.

"Upholstery should be thoroughly protected from moths with a minimum of four one-half pound cakes of naphthalene when placed in storage, and every 60 days thereafter with one half-pound cake. Openings around foot pedals should be protected with screening or metal to keep out rats and mice. The body should be air-tight through closing all doors, windows, and ventilators, so that the naphthalene can do its work.

"Batteries deteriorate and should be stored where they can be charged regularly and the solution kept at the proper level."

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TRAIN—The hobby of playing with toy trains now has more than 100,000 American men enthusiasts, who have invested at least $10,000,000 in their equipment and support three hundred local clubs, three magazines, and a national association which holds annual conventions. One millionaire even has one of these miniature railroads installed in a Wall Street building, where it occupies two entire floors.

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FOREST RADIO

Antenna Needs No Insulation

ONE of the new devices for use in emergency radio communication, now aiding the United States Department of Agriculture's Forest Service in the current and continuing fight against fires, is a simplified radio antenna perfected recently at the Forest Service's Radio Laboratory

The new forest radio antenna has no insulators, requires no elaborate installation, and can be pre-tuned before installation. Costing but a small fraction of what the usual commercial antenna costs, it is called the PD ("plumber's delight") antenna by forest rangers because it can easily be made from simple materials like pipe and fish poles and installed with the aid of a few plumbers' tools. The fact that no insulation is necessary prevents power losses and reduced efficiency due to insulator leakage. Resistant to snow and ice, the antenna is especially suitable for lookout stations at high elevations.

It is equally effective on wood and metal buildings. Another asset is that instead of representing a lightning hazard, it acts as a lightning rod, adding to the safety of the structure to which it is attached and of the occupants. Reduced to barest essentials, the PD antenna consists of a vertical radiator, working against a ground established by four horizontal quarter-wave radials. For Forest Service radio frequencies, the antenna is only six to seven and one-half feet long.

MOBILOPSHOP

Army Spectacle Wearers Have Fewer Worries

OVERSEAS soldiers who break or lose their spectacles in camp or on the battlefield will have them repaired or replaced in the field by mobile optical shops, first of their kind to be attached to United States field armies

The first of these units, built by the American Optical Company, and commanded by Captain J. R. Harrison, was designed at the request of the Surgeon General's office. It contains optical machinery, 36,000 lenses, 8400 frames, 600 pairs of extra temples, and 1200 spectacle cases A total of 120 single lenses can be edged and mounted daily, which is estimated to be sufficient for the average requirements of a field army of 300,000 men

Approximately 15 percent of the men in the armed forces wear glasses. In World War I an optical shop was set up for the A E F in a suburb of Paris. As it was stationary, speedy

Mobile Army eyeglass shop satisfies requirements of a field army of 300,000 men

Men in the Armed Forces

— Soldiers, Sailors, Marines —

Would Appreciate a Gift Subscription to Scientific American

As a gesture to those hundreds of thousands of American men who have severed their home and business ties to do their part in building up the Army, Navy and Marine Corps of the United States, Scientific American is making a special offer of half-rate subscriptions when mailed to members of our armed forces.

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spectacle service to the soldiers in the field was impossible. A member of the present editorial staff of this magazine, whose glasses were broken in line of duty, was forced to journey to a distant city, find a French optician's shop, and pay for the replacement from his own pocket.

In the present war each soldier who wears glasses will have a copy of his prescription attached to his service record at the headquarters of his respective organization. When he needs glasses, he applies to headquarters for the necessary authorization, after which the optical unit swings into action. Thus, today, they are doing things better.

IT'S IN THE CRYSTAL

New Form of Paint

Pigment Covers Better

The patterns of the crystals composing titanium dioxide—the whitest white substance man has yet found for making and keeping white paints white—are physically at considerable variance. One of the three known types of titanium dioxide crystals is as compact as a clenched fist; the titanium and oxygen atoms in one of the other crystals are arranged in an open, loose fashion. Herein lies a minute difference of mighty significance.

Pigments that go farther

This pair of titanium dioxide crystals—left to right, in the picture—are known as rutile and anatase. Rutile, the chunky fellow, is a newcomer After ten years of research, the Krebs Pigment & Color Corporation, E. I. du Pont de Nemours & Company, Inc., is now able to make its whiter-than-white titanium dioxide pigment in the form of rutile crystals.

Previously the pigment that revolutionized the formulation of white paints came in the form of anatase titanium dioxide—which had more than double the hiding power of any previously available white pigment. Now, with white pigment available in rutile form, hiding power is increased another 25 to 33 percent. To put it in another way, a rutile enamel can be used to cover one third greater area than an anatase enamel without any increase in the "show-through" of the background. The manufacturer can make four gallons of paint with "Ti-Pure" R—the official name for the new rutile form titanium—where he could only make three with the anatase grade. And this is all due to the fact that the compactness of the new rutile crystal affords a higher index of refraction—or hiding power—than any other titanium pigment available today. Rutile titanium, in the language of the paint-maker, means more "covering power"—greater mileage for enamels and lacquers as well as white paints.

• • •

POWER—Start of long-distance transmission of electric power was recently recalled when the world's first alternating current waterwheel generators at Niagara Falls were returned to service for the duration of the war. Built in 1896, these 10 machines had been retired for 17 years as stand-by equipment. They were installed in the Edward Dean Adams Station at Niagara Falls, by Westinghouse, 45 years ago to produce the power which was sent over wires to Buffalo, New York, 20 miles away.

• • •

ROAD CORRUGATIONS

Caused by Air, According

to New Theory

In a paper reported in *The Journal of the Institution of Engineers*, Australia, Alan Price recently discussed the cause of road corrugation on certain types of paved and unpaved surfaces. He states that it is a mistaken idea that corrugation results from the frictional action of motor car wheels. He points out that, if this were so, the corrugations would occur only adjacent to the wheel tracks, whereas actually they are found to extend right across the road width, and he postulates the theory that they are the direct result of air currents produced by the motion of the car.

Observations and experiments are quoted by Mr. Price to show that wind, or air currents, have wavelengths which eventually bring about "heaps" or corrugations at right angles to the directions of flow; in the case of a road, however, these corrugations do not occur exactly normal to the center line, but lie slightly forward from left to right. The reason for this latter phenomenon is that the air stream is not running parallel to the center line, because the camber of the road induces the current to follow the line of least resistance and to swerve somewhat to the left; this results in two sets of corrugations—one on either side of the pavement—parallel to each other, but frequently breaking step at the center, making this generally the most uncomfortable portion of the road on which to travel.

BLAST CUSHIONING

Glass-Fiber Panel For

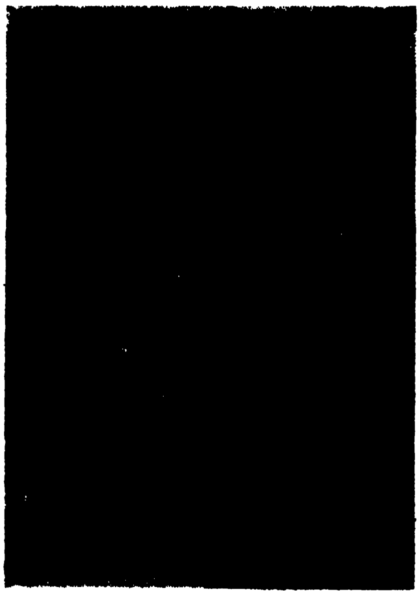
Factory Blackouts

A new blast-cushioning, incombustible glass-fiber material for blacking out war-production plants is designed to reduce damage from concussion and to provide protection against the spread of fire caused by incendiary bombs or explosives.

Known as Fiberglas OC-9 Board, the new material is composed of fine, resilient glass fibers compressed and treated with a binder which gives it sufficient rigidity to serve as a self-supporting, fire-resistant material. The material can be faced with glass-fiber cloth, plywood, or other surfacing materials.

Experience in England has shown that even fairly distant bombing may prove highly destructive to industrial operations by shattering windows, scattering death-dealing glass fragments, and disrupting delicate instruments Although the concussion-absorbing qualities of the compressed glass fibers cannot provide complete protection against nearby blasts, the resilient, light-obscuring and protective materials may prove of definite value by absorbing part of the concussion caused by explosions.

A recent demonstration of this panelling was the first showing of the



Reduces damage from bomb concussions

use of glass-fiber materials for blacking out existing industrial plants Large quantities of glass fiber products were, however, used for heat insulation and sound absorption in the fire and shatter-resistant walls, and the fire-resistant roofs, of two huge blackout bomber assembly plants already built.

RISKY

Black Widow Spider Menace Is No Joke

In the "Annals of Surgery," Dr. H. T. Kirby-Smith cites evidence that privies are a major menace because they so often harbor the highly venemous *Latrodectus mactans.* As abstracted in *The Journal of the American Medical Association,* his findings show that bites by the black widow spider occur more frequently than is generally supposed. He has collected 15 cases from the records of the Vanderbilt Hospital and has encountered nine cases during five years of private practice. Fourteen of the 24 patients actually saw the spider, and the history and subsequent course of symptoms of the other 10 leave no doubt that they were bitten by the black widow.

Eleven of the bites were on the penis, four on the buttocks, one on the scrotum, one on the thigh, four on the arms and hands, one on the chest, one on the knee, and the site of one was not mentioned.

Sixteen of the victims were bitten while in a privy. Twenty-two of the patients were male. Symptoms ensued from 5 minutes to two and a half hours after the bite. The bites were inflicted from April through October. There was 1 death. Death following a bite by a black widow spider is uncommon.

SPRAY CHECK

Makes Possible Rapid Study of Insecticides

A PRECISION sprayer and duster devised by scientists at the New York State Experiment Station, which make it possible to deposit fungicides on one half of an apple leaf, leaving the other half as a check, are aiding in more rapid evaluation of the effectiveness of new spray materials for the control of orchard diseases.

"In the orchard," say the Station specialists, "the environment must be accepted as it is without control and the complexity of factors that affect the results make it difficult to come to any definite conclusions. Also, years of experimentation may elapse before conditions suitable for certain phases of a study are encountered. Orchard trials will always remain the final test of effectiveness of spray materials, but laboratory and greenhouse procedures which duplicate orchard conditions most closely provide a rapid and economical method of testing new fungicides, and also open up possibilities for much fundamental research about fruit diseases and their control."

Three different types of precision sprayers have been designed. For the most rapid testing of fungicides, particularly sulfur, glass slides are sprayed with the materials under test and the spore suspensions of the desired fungus are applied to the slides to determine the comparative values of different sprays. More reliable tests on foilage grown in the greenhouse are made with a horizontal type of sprayer which makes it possible to spray one half of a leaf, leaving the other half as a check.'

To duplicate orchard conditions, a small model orchard sprayer has been set up in the laboratory. This does not give as accurate control as the precision sprayers, but very uniform and reproducible coverage is obtained by placing the potted trees on

A New Star over America

THIS is the new All-Navy "E" burgee. With its added star, it signifies that, for a period of over six months, production of Navy material has been apace of schedule. First flown in America over the Bausch & Lomb plant, it is official Navy recognition to B&L workers of their continued achievement in Production for Victory. It replaces the Bureau of Ordnance flag and "E" pennant awarded Bausch & Lomb July 25, 1941.

The Navy "E" has always been an honor to be striven for, to be guarded jealously. On gun turret, battleship funnel, or the flagstaff of an industrial plant, it is a symbol of championship performance. But today, Navy officials—and the American public are anxious to see this award in as many places as possible. Because "championship performance" is what America needs today all down the line.

Workmen at Bausch & Lomb are devoting to the specific implements of war, the experience and skills gained in the production of scientific optical instruments. Today the world depends on America's men-behind-the-men-behind-the-guns to destroy the forces of aggression—that the ideals of individual freedom may survive.

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ASTORIA APARTMENTS...one-room apartments that "live" like three rooms...for restricted budgets.

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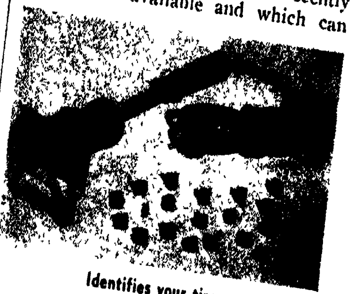
a turntable and passing them through the spray for a definite period of time.

BRANDING TORCH

For Tires, Protects Against Theft

FLEET owners and garage men are finding plenty of use for a tire branding outfit which has recently been made available and which can



Identifies your tires

go far toward preventing tire thefts. This branding torch, illustrated in these columns, is heated electrically, the heat being transferred to interchangeable letters which are firmly fastened in the slotted face of the tool.

• • •

SUGAR—A single acre of sugar beets produces, according to the United States Beet Sugar Association, approximately 3100 pounds of granulated sugar, as well as enough by-products for feed to produce 253 pounds of beef or lamb.

• • •

END BRUSH

Designed to Clean Welded Joints

A POWER-DRIVEN end brush, made by The Osborn Manufacturing Company, is designed particularly to facilitate the cleaning of slag, scale, or oxidation from welds on inside corners, as well as in other locations which are

Brushes hard-to-get-at welds

difficult of access. It is claimed that this new brush will get into any space which is accessible for welding; it takes no more room to manipulate the brush than it does to weld. The brush can be used in all standard power tools, whether air or electric

FUMIGANT

Kills Insects in Grain and Flour

A NEW fumigant for grain and flour, highly penetrating and deadly to insects but harmless to humans, is announced by the University of New Hampshire. The compound, chlorinated nitroethane, is a clear liquid with a distinct but not disagreeable odor, stated to be safe to ship in ordinary containers. It evaporates readily on exposure to the air, and the fumes penetrate quickly even into large masses of grain or flour A simple method of fumigating grain in cars consists of putting the chemical on top of the grain and then sealing the car.

INDICATOR LIGHT

Gives Visual Indication Of Circuit Break

A SMALL panel indicator light which goes on only when an electrical current is broken is now finding use in railroad signalling equipment, in aircraft applications, and in many other circuits where a remote indication of trouble is desirable.

Operates only when circuit is broken

When this indicator light, manufactured by Littlefuse, Inc, is installed at any convenient point in connection with a remote control setup, it works instantly, giving a plainly visible signal. The lights are available either with filament bulbs or neon lamps which will glow on currents as low as 100 microamperes.

INTER-AMERICAN

Highway Now More Than Half Completed

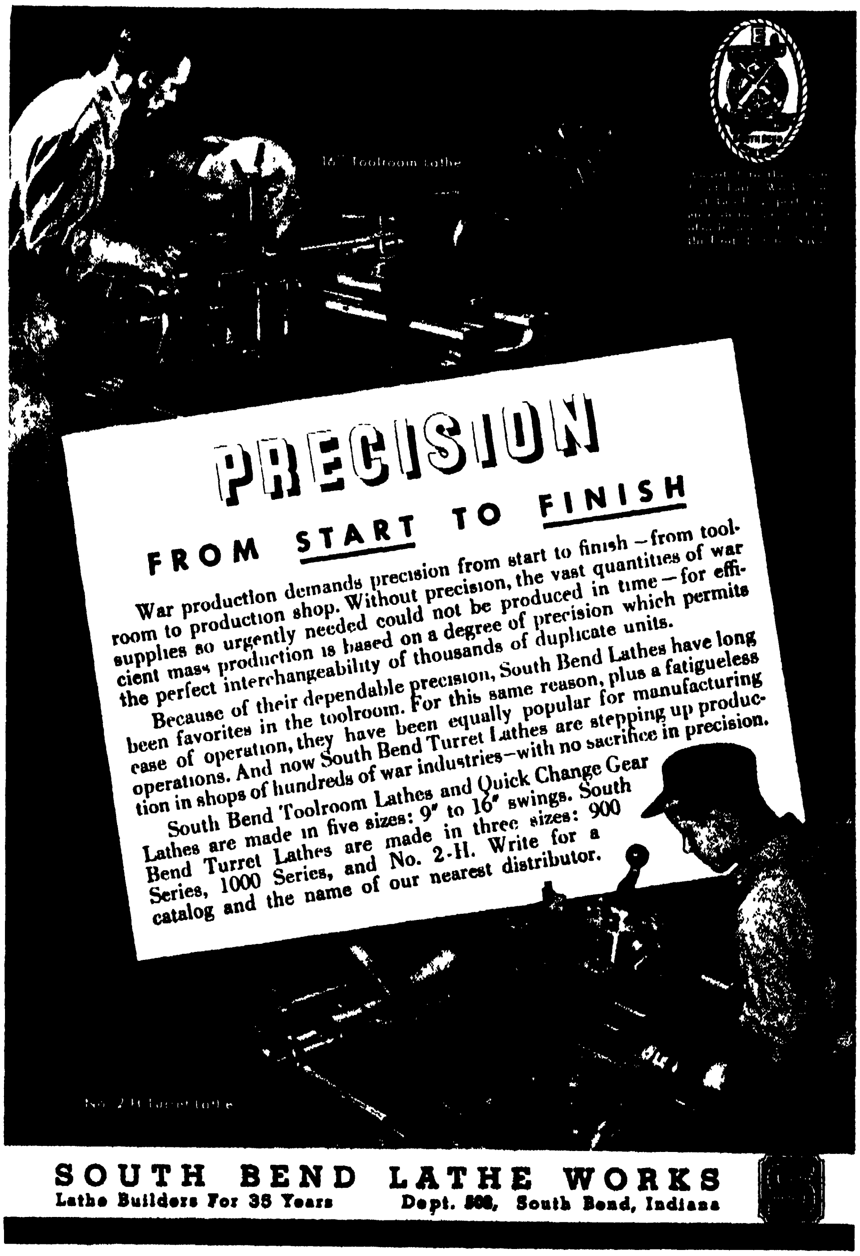
LINK by link, the great Inter-American Highway is being built from the United States through Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama to South America. Approximately 3,500 miles of all-weather surfaced road is involved and more than half of it is already completed and open for travel, although the completed segments are not all continuous.

The longest section of the Inter-American Highway which has been opened to automobile travel to date is a stretch of over a thousand miles extending from Laredo, Texas, through the greater part of Mexico. Most of this section is surfaced with asphaltic materials. It was actually started some 15 years ago. Each of the Central American countries has constructed an extensive strip of the highway but shorter lengths remain to be finished. Guatemala was the first to improve its entire mileage (300) for all-weather travel. Impassable trails still exist at certain points along the route through Central America. However, completion is now within sight.

Effect of the new highway will be far reaching. Tourists will find within easy range the historical land of the Aztecs and the early Spaniards, the floating gardens of tropical lakes, and the snow-covered volcanos of continuous mountain ranges.

From the standpoint of business the highway will be especially important because it will open up rich producing regions of rubber, wool, hard rice, tea, cinnamon, camphor, coffee, quinine, copra, oils, varnish gums, abaca hemp, and many other commodities including rare woods.

The Inter-American Highway is being financed by the United States and by all the countries through which it passes. Its construction utilizes the latest tools of the modern world. A



PRECISION

FROM START TO FINISH

War production demands precision from start to finish—from toolroom to production shop. Without precision, the vast quantities of war supplies so urgently needed could not be produced in time—for efficient mass production is based on a degree of precision which permits the perfect interchangeability of thousands of duplicate units.

Because of their dependable precision, South Bend Lathes have long been favorites in the toolroom. For this same reason, plus a fatigueless ease of operation, they have been equally popular for manufacturing operations. And now South Bend Turret Lathes are stepping up production in shops of hundreds of war industries—with no sacrifice in precision.

South Bend Toolroom Lathes and Quick Change Gear Lathes are made in five sizes: 9" to 16" swings. South Bend Turret Lathes are made in three sizes: 900 Series, 1000 Series, and No. 2-H. Write for a catalog and the name of our nearest distributor.

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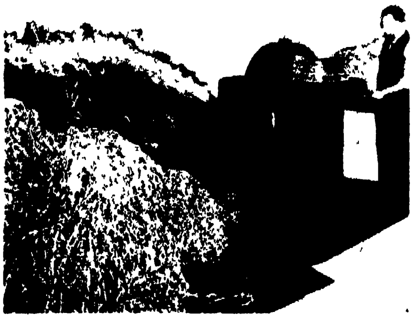
With this machine, manufactured by Mitts and Merrill, fresh packing material is readily made from paper that otherwise might be baled and sold, thus obviating the necessity of purchasing new packing material The shredding knives in the machine are made of hardened tool steel which, it is claimed, will cut light metal such as paper clips, staples, pins and so on, without injury to the cutting edges.



Make your own paper excelsior

PSYCHIC VACCINATION

Rats Made Immune to Noises by Other Noises

PSYCHIC "vaccination" against the nerve-shattering effects of war noise is a future possibility, it is suggested by a report recently made to the Mid-western Psychological Association. Noise-sensitive rats that ordinarily would be thrown into fits similar to epileptic seizures by certain shrill or irritating noises have been made immune to the seizure-producing sounds, according to Dr. Norman R. F. Maier, of the University of Michigan. The immunity lasted for several days.

The protecting treatment consisted merely of preceding each seizure-producing noise with another to which the rat is not sensitive. Continuation of this procedure with daily tests for about two weeks makes it possible to expose the rats to the seizure-producing sounds without harm. After a week without tests, the animal is again susceptible.

The noise-induced seizures in rats are due, Dr. Maier concludes, to nervous tensions, and if enough preparation is given, the organism can adjust. In states of low energy the tensions are not sufficient to break through and get control of the animal.

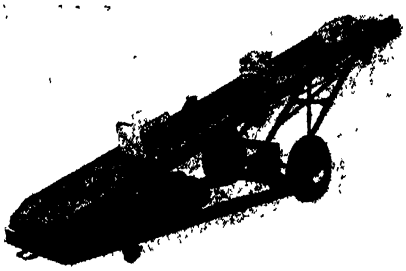
Just how closely the noise-induced fits of susceptible rats resemble the jumpy, jittery nerves produced in some humans by the explosive blasts, shrieking shells, and roaring dive bombers of modern war is not yet known to psychologists. But the fact that a means has been found for protecting the rats by this sort of psychological immunizing process raises hope that some similar method may be developed for helping humans to protect their nerves against war damage—*Science Service.*

CONVEYOR

Portable Unit Has Variable Incline

A PORTABLE conveyor for use in piling boxes, bales, and other materials, illustrated in one of our photographs, is provided with rubber tired wheels which make it possible to move the machine from one site to another by simply hooking the lower end of it to a motor truck.

The belt on this new conveyor rides on rollers mounted in a structural frame that is hinged to a supporting frame so that the discharge end may be raised and lowered from a minimum of four feet to a maximum of eight feet. Elevation of the unit is accomplished by a hand crank and geared drums.



For piling, loading, and unloading

The belt of the conveyor is driven by a motor and speed reducer with chain connection to a pulley at the lower end. Adjustment of the belt is accomplished through an idler pulley at the upper end. This unit, known as the Portable Belt Piler, is manufactured by the Standard Conveyor Company.

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LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS

	Inlet	Outlet	Price	With A. C. motor
No 1 Centrifugal	¼"	⅛"	$ 6.50	$25.00
No 4 "	¾"	½"	13.50	32.00
No 9 "	1¼"	1 "	16.50	35.00

No					With A C motor
No 1½	Gear	⅛"	Price	$ 9 00	$25.00
No 2	"	¼"	"	10 00	27.50
No 3	"	⅜"	"	11.50	28.50
No 4	"	½"	"	12.50	32.00
No. 7	"	¾"	"	15 00	37.50
No 9	"	1 "	"	16.50	49.50
No. 11	"	1¼"	"	48.50	on request

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Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

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SIZE	H P	R P M	C F.M	PRICE
24"	1/6	660	4200	$45.00
30"	1/6	540	5800	52.00
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3 Amp.	1.65	35 Amp	5.50
5 Amp	1.65	65 Amp	11.00
10 Amp	2 00	200 Amp	50.00

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Other voltages & frequencies available at slightly higher prices

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TYPE	H.P	R P.M	CU FT MIN	INLET	OUTLET	PRICE
0	1/20	1750	160	4½"	3¾"	$22.00
0½	⅛	1750	350	6½"	3¾"	25.00
1	1/6	1750	535	6 "	4½"	30 00
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What Strange Powers Did the Ancients Possess?

EVERY important discovery relating to mind power, sound thinking and cause and effect, as applied to self-advancement, was known centuries ago, before the masses could read and write.

Much has been written about the wise men of old. A popular fallacy has it that their secrets of personal power and successful living were lost to the world. Knowledge of nature's laws, accumulated through the ages, is never lost. At times the great truths possessed by the sages were hidden from unscrupulous men in high places, but never destroyed.

Why Were Their Secrets Closely Guarded?

Only recently, as time is measured; not more than twenty generations ago, less than 1/100th of 1% of the earth's people were thought capable of receiving basic knowledge about the laws of life, for it is an elementary truism that knowledge is power and that power cannot be entrusted to the ignorant and the unworthy.

Wisdom is not readily attainable by the general public; nor recognized when right within reach. The average person absorbs a multitude of details about things, but goes through life without ever knowing where and how to acquire mastery of the fundamentals of the inner mind—that mysterious silent something which "whispers" to you from within.

Fundamental Laws of Nature

Your habits, accomplishments and weaknesses are the effects of causes. Your thoughts and actions are governed by fundamental laws. Example: The law of compensation is as fundamental as the laws of breathing, eating and sleeping. All fixed laws of nature are as fascinating to study as they are vital to understand for success in life.

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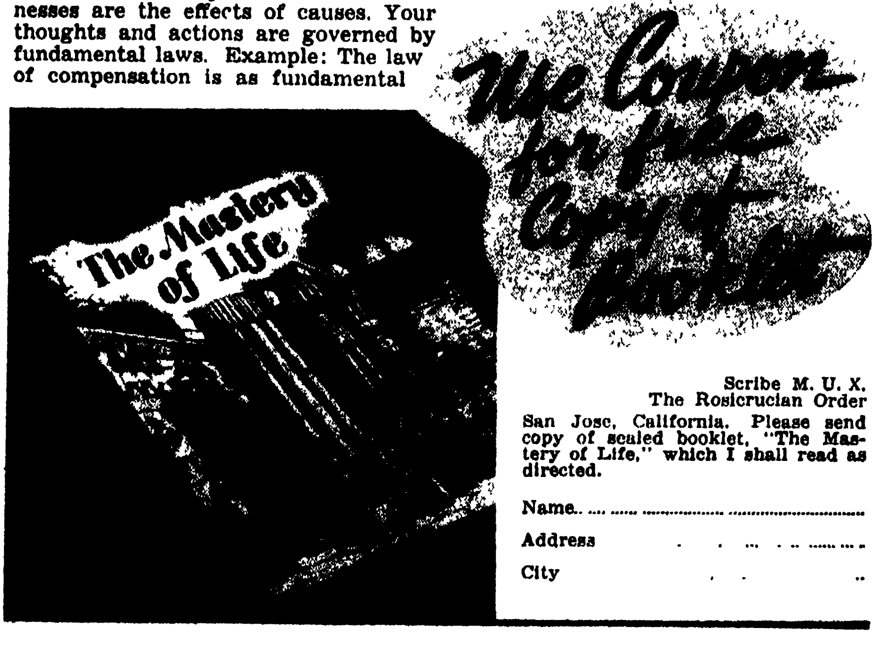
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SEA NESTS FOR WAR BIRDS

By Walton L. Robinson

Continued from page 54

5-inch guns are of a new model and can be used with equal effectiveness against warships or aircraft. They comprise the main armament of all our modern destroyers and of the four 6000-ton light cruisers of the speedy *Atlanta* class, which are now joining the fleet. They also constitute the secondary battery of the new battleships *North Carolina* and *Washington.*

Maximum aircraft capacity of each of these carriers is over 100 planes, but in normal service the *Enterprise* accommodates 81 aircraft—a 75-plane Air Group and 6 utility planes. Her combatant aircraft comprise one squadron of torpedo planes, one of bombers, one of fighters, and one of scouting planes. The *Yorktown,* flagship of Aircraft, Battle Force, Pacific Fleet and Carrier Division Two, has the same aircraft complement plus a four-plane Flag Unit. One of the most interesting features about these ships is their ability to catapult their aircraft from the hangar deck as well as from the flight deck This is a great advantage, for it increases the number of planes which can be put into the air at short notice

The *Yorktown* and *Enterprise* are much more stoutly armored than the *Ranger.* They have a heavy protective deck and a patch of side armor, unofficially reported to be four inches thick, over machinery and boiler spaces, and the usual internal sub-division. They are also very fast—the fastest carriers in our Navy and probably faster than any foreign ones. Their 120,000 horsepower geared turbines, driving four propellers, give them a designed speed of 34 knots, which they have exceeded on trials. Steam is supplied by nine Babcox and Wilcox express type boilers.

In general appearance these ships bear some resemblance to the *Saratoga* and *Lexington,* though they can easily be distinguished from them. They have a fairly large flat-sided funnel, tripod mast, and considerable island superstructure on the starboard side of the flight deck, but no gun-houses such as in the older and larger carriers. In peace time it was possible to differentiate between them by the large black "Y" painted on both sides of the *Yorktown's* funnel.

The 14,700-ton *Wasp,* laid down April 1, 1936, by the Bethlehem Steel Company and commissioned four years later at a cost of nearly $21,000,000 (exclusive of armament and aircraft), is a smaller edition of the *Yorktown* with certain features of the *Ranger's* design. Her hull lines closely follow those of the *Ranger,* but her superstructure, save for her smaller funnel, resembles the *Yorktown's* in general arrangement. On the water-line the *Wasp* is 688 feet long and 80 3/4 feet wide and in a light condition draws 20 feet. She is, therefore, 40 feet shorter than the *Ranger,* but slightly wider and deeper in the water. Her over-all length is 739 feet. This is also the length of her flight deck, which extends beyond the over-hanging bow and stern. Her armament is the same as the *Yorktown's* and her protection generally similar to the *Ranger's.*

The *Wasp* carries two squadrons of scouting planes, two of fighters, and six utility planes—a total of 84 aircraft. Her engines, Parsons geared turbines, develop 55,000 horsepower for a designed speed of 30 knots.

America's newest regular carrier, the $32,000,000 *Hornet,* was commissioned last October—some months ahead of schedule. She was laid down September 25, 1939, and launched December 20, 1940, by the Newport News Shipbuilding Company. Details concerning her are restricted, but it is known that she is a modification of the *Yorktown* design, incorporating a number of improvements. Her waterline length has been reported at 770 feet and her displacement at over 20,000 tons. From photographs it is evident that she varies only slightly in appearance from the *Yorktown.* Most of this difference is to be found in the island superstructure.

● READERS of the accompanying article on aircraft carriers, and of other articles on naval matters in monthly magazines, must always bear in mind the time-element involved in the publishing business and in the release of information by the Government to writers and editors. Thus, Mr. Robinson's article was written and set in type after the Battle of the Coral Sea, but before the details of that battle were released. Hence it will be understood why the carrier "Lexington" is written of as a ship in being, whereas she actually was destroyed as a result of that engagement.—The Editor. ●

Our eleven carriers under construction or on order are expected to be ships of around 25,000 to 26,500 tons and to cost in the neighborhood of $60,000,000 each. The *Essex, Bon Homme Richard,* and *Cabot* are scheduled for completion next year, while most of the others will follow in 1944-45. They will be welcome additions to our Navy in its life-and-death struggle in the Pacific and in its efforts to assist Britain in maintaining the vital lines of communication in the North Atlantic.

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BRAZING

With Induction-Heating Equipment

SKILLED labor is not necessary for the operation of a new induction-heating unit for brazing assemblies of various types. The unit shown in one of our photographs was designed to braze a steel tube and a steel hexagon head, but the effectiveness of this particular job may suggest other brazing or metal-treating operations which will facilitate production and decrease labor and material costs.

The equipment used in the unit shown, manufactured by the Induction Heating Corporation, consists of a high-frequency generator of 20-kilowatt rating and a double seven-place heating coil. With this double unit, seven working assemblies are heating or cooling on one side while seven others are being removed or set up on the other. A silver brazing alloy is used which penetrates quickly through the joint, the resulting strength of the joint, it is claimed, being as high as or higher than the solid parts.

Skilled labor is unnecessary

STICKERS

For Identification, Are Easily Removed

A NEW type of dry sticker having a special adhesive substance that makes it particularly adaptable for use in defense plants is being used for inspection, rejection, instruction, and identification purposes where speed and accuracy are important. Sold under the trade name of Kum-Kleen Stickers, it is claimed that they overcome many of the disadvantages of ordinary labels, tags, and markings. They are applied quickly, without moisture, on any smooth surface, including polished metal, glass, and plastics, simply by a slight finger pressure. Unaffected by intense heat, cold or humidity, they stick permanently, though they may be peeled off easily by hand without leaving a stain or mark.

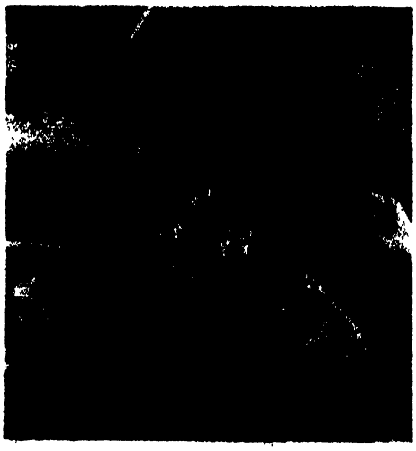
ANY ANGLE

Tool Vise Can be Firmly Locked in Position

COMPLETE in itself, a new tool vise that can be locked firmly at any angle is mounted on a lug base which is easily affixed to a machine table.

The vise, designed particularly for tool grinding, is constructed on a double-cradle principle permitting adjustment of grinding angles on three separate planes. Two closely machined steel blocks, rounded on the bottom, are cradled into each other at right angles. After adjustment, they are solidly locked together by tightening cam locks operating in machined segments at ends of the respective blocks. Mounted atop these two blocks is a flat, circular piece which swivels 90 degrees from center of any of the four sides of the block immediately below. This piece carries the vise jaws, holding tools firmly by means of Allen screws.

The principle of closely fitting steel blocks which may be tightly locked together permits of absolutely no vibration or deflection, thereby insuring maximum accuracy of the grinding

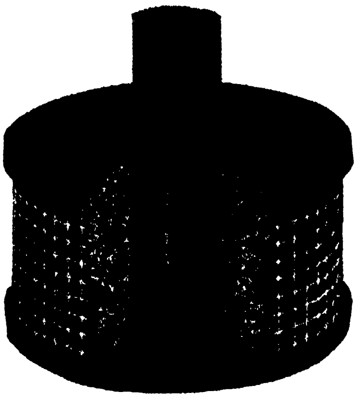

Universal positions for tool-grinding

angle selected. Readings on each block are clearly marked. Each tilts 15 degrees either way from horizontal, and this adjustment, combined with 360 degrees selectivity of the circular piece at top, provides almost any angle desired. The vise has been placed on the market by Hammond Machinery Builders, Inc.

COOLANT STRAINER

Strains Chips and Cuttings from Fluids

For machines which require the use of a coolant, a new strainer has been developed which removes metal chips and cuttings remaining in suspension, permitting only chip-free cooling solution to pass through the pump. This strainer, made by Metal Textile Corporation, is claimed to save general wear and tear on pumps, to conserve coolant, and to increase production speed Tests of the strainer reveal that on "dirty work" machines, operations can be continued without interruption for four to six weeks before cleaning of the strainer is necessary.



Saves production interruptions

BAND SAW

Cuts Steel As If It Were Cheese

Metal-cutting band saws that will cut 18-inch thicknesses of the toughest die steel at a rate of six and one-half linear inches per hour have recently been developed for contour sawing. The specialized equipment used for this purpose has been designed through constant research on band saws and their cutting edges. Progress in this work has extended to a point where, it is claimed, a 3/32-inch wide saw can now be produced with about the same relative cutting efficiency as a half-inch saw.

One of our illustrations shows one of these new metal-cutting band saws developed by Continental Machines, Inc., in use shaping airplane parts. The inset picture shows a saw notching a 12 inch by 3 inch machine part. The saw illustrated will cut one-inch tool steel at a rate of 140 inches per hour.

The process of contour sawing with these new and efficient band saws permits shaping of the most complicated outlines in almost any material used in any industry. Aside from saving a considerable amount of time over conventional or basic cutting machines, contour saws make it possible to save practically all material not actually used to produce the parts being shaped or formed.

For shaping as well as for notching

ELBOW

For Plumbing Use Made of Plastic

Critical metals are again conserved in the plumbing trade by a new flush elbow for connecting the tank to water closets. The problem has been efficiently solved, and an advance has been made in material adapted for the purpose, in one-piece molding of the flush "L" in tough resistant plastic, by American Molded Products Company.

This "L" is an elbow connection of tank and bowl heretofore commonly made of copper or brass, and supplied by tubular metal manufacturers. With restrictions on the metals, the trade has been much concerned about the supply.

The new "L" provides strength with lightness; it does not break, crack, or dent in the usual packing and handling with tools. It is stated to be leakproof, impervious to water or to iron, lime, sulfur, salt, or other water-carried material, and to be non-corrosive. It is made of a porcelain-like, white, odorless plastic with a smooth finish inside and out. There is no enamel, paint, or plating to chip, crack, peel off, or tarnish.

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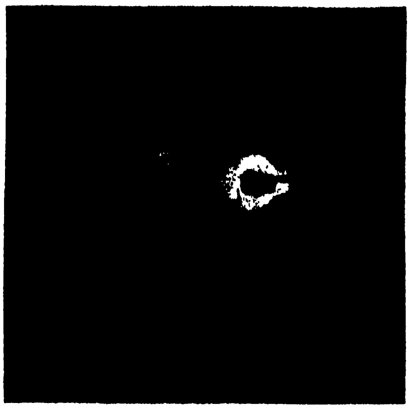
Tales Told By Ears

Oxygen Saturation of an Aviator's Blood, Which Determines His Efficiency, is Quickly Measured

ALEXANDER KLEMIN
Aviation Editor, Scientific American, Research Professor, Daniel Guggenheim School of Aeronautics, New York University

A NEW device with the odd name of the "Oximeter" has greatly increased the usefulness of the altitude chamber at Wright Field, where experiments are constantly being made in regard to the effect of high altitude on the military pilot. The measure of a man's efficiency in the thin air of high altitudes is given by the oxygen saturation in his blood; if the normal reading is 95 percent at sea level, it may drop to 75 percent at 40,000 feet, even if an oxygen mask is employed, because the atmospheric pressure is so low that the subject's body cannot absorb enough oxygen to sustain life without the added protection of a pressurized suit or cabin. Exercise hastens the rate at which the oxygen content of the blood drops. At a rating of 70 percent, a man's judgement becomes unreliable, dizziness and mental confusion set in at 60 percent, and complete loss of consciousness results at 50 percent.


A soldier inside the altitude chamber with Oximeter attached to ear

Previously existing methods of determining the blood oxygen content have been slow and somewhat unreliable, but the Oximeter, designed by Dr. Glenn A. Millikan, allows rapid determinations to be made by a medical man seated comfortably outside the altitude chamber within which tests are being made. The key to an understanding of the Oximeter is a U-shaped ear-unit, with a tiny exciter lamp on one side and a light-sensitive photocell on the other. This unit clamps on the lobe of the subject's ear, so that light from the lamp shines through the lobe into the photocell. We quote Dr. Millikan: "The Oximeter capitalizes on the fact that blood changes color as its oxygen contact changes—normally saturated it is bright red, but as more and more oxygen is lost it shades off to deep purple. Purple passes less light than red, so any change in the oxygen content of the blood alters the intensity of the light which shines through the ear lobe. These changes are relayed from the photocell by wires leading through a box of resistance coils to a galvanometer. There is lag of from one to five seconds between a true reading and the actual condition of the bloodstream. This is the time required for blood to circulate from the heart to the ear. Since light obviously can penetrate a thin lobe easier than a thick one, it is necessary to determine the thickness of the subject's lobe at the outset. Lobes are classified as shell, wafer, thin, medium, or thick so that the proper scale reading on the galvanometer can be chosen."

Observer records readings of Oximeter

Many successful applications of the Oximeter have been made and it has proved to be highly useful in aeromedical research.

CARGO PLANE

For the Army, Made of Plywood

IT is no secret that one of the problems of the United Nations is transportation, that transportation by surface

Artist's conception of the new cargo-carrying plane, Curtiss C-76

vessel is slow, that air transport is a tremendous help in carrying supplies and equipment and is likely to grow in importance as the war goes on. The United States Army Air Forces are fully cognizant of the situation and are ordering large numbers of cargo-carrying planes. What is more, these new cargo planes will be built of wood and other non-strategic materials not on the Government priority lists. Again, so as not to overburden the resources of the aircraft plants building combat machines, a majority of the parts of the Curtiss C-76 (as an important new military cargo ship is called) will be built in small assemblies by manufacturing organizations which are experienced in plywood construction

The site for construction of the C-76 will be somewhere in the East, and many men with woodworking skill are being gathered for the new plant—whose exact location must, of course, remain a secret. Secrecy also must shroud the design of the plane itself, which is shown roughly in the artist's sketch. All that the sketch reveals is a clean, twin-engine plane of about the size of the twin-engine transports operating on our airlines. Whatever the design, the effort is commendable.—*A.K.*

RESEARCH

A Few of the Many Aerodynamical Problems

The Annual Report of the National Advisory Committee for Aeronautics, which is transmitted by the President to Congress, gives, as usual, a comprehensive review of the research problems which are attracting attention of American scientists—even though the actual results of such investigations remain shrouded in secrecy.

The introduction to the report indicates in interesting fashion the desirable lines of aeronautical development. Thus, the outstanding fighters of 1940-1941—the British *Spitfire* and *Hurricane* planes, and the German Messerschmidt 109 F—had maximum speeds of the order of 360 miles per hour. The American aircraft program must provide new fighters of much higher speed, well over 400 miles an hour To do this, it is hardly sufficient to increase the horsepower and clean up the airplane aerodynamically. It is necessary to develop entirely new wing sections of the low-drag, laminar flow type, and it is essential to re-examine the methods of cowling and cooling. Special cowlings are needed to handle the air needed to cool the engine, the oil radiator, and the intercooler which cools the air after it has left the supercharger and before it reaches the engine.

Propellers of usual design are inefficient at very high speeds, so that new propeller blade sections have to be developed. At high speeds, the airplane is subject to "compressibility" or shock wave effects, and wings, fuselage, and other parts must be designed to eliminate "compressibility" effects as much as possible.

These are but a few of the problems considered by the Committee whose laboratories must also work on the engine, aircraft structure, and innumerable other questions.—*A.K.*

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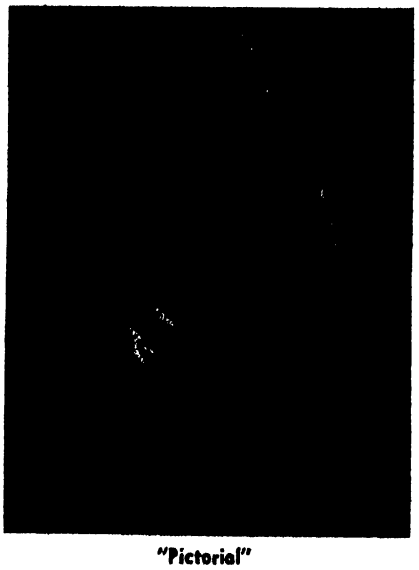
Record or Interpret

The line distinguishing the record picture from the so-called pictorial, or interpretive shot, is sometimes so very thin that none can blame judges when they fall to squabbling among themselves as to whether a particular print should be accepted or discarded on this ground. The pictures of iris here reproduced are a case in point.

To our mind, "Record," despite some evidences of attempts to pictorialize the subject, is still a record. The requirements of flower photography, that the subject should be given form and texture and that proper lighting, development, and printing should bring out both highlight and shadow detail, are fairly well fulfilled. Two Photofloods in reflectors were used for illumination, one overhead, the other roughly frontal and at some distance from the subject to fill in the shadows without destroying balance and highlight detail. Development of the Eastman Super Panchro Press negative was in a much used D-76 solution.

"Record"



"Pictorial"

"Pictorial," on the other hand, hits nearer the mark as an example of interpretation. Less light and a somewhat low key effect give the desired result; to balance the gracefully tapering buds with the open flower. One Photoflood, above and a little to one side, outlines the buds and the stems but illuminates the flower sufficiently to provide satisfactory over-all lighting.

The pictures were made indoors, using a small graduate as a support, with a medium gray cardboard to serve for the background.

Sunlight After Rain

The amateur with foresight knows that there's always the chance of the silver lining after the darkness of the storm. He knows that rain does not last forever and that when the sun shines afterward, there are pictures a-plenty. Looking forward to just such an eventuality we took the camera along one rainy day and were rewarded with the chance to shoot "Sunlight After Rain." To make the most of the mud puddles, we held the camera low, taking advantage of the sunny gleam on the roof under the tree to record the cheery effect of sunlight after rain.

"Sunlight After Rain"

M-Q Versus Pyro

Which is better, the modern metol-hydroquinone developers or the venerable pyro formulas? The Agfa Ansco Research Laboratories recently made some tests to find out. Two M-Q developers, Agfa Ansco Nos. 17 and 47, and the three-solution pyro formula, Agfa

Ansco No. 45, were used. A straight test showed the following: pyro developed films had better tone separation in the shadows, steeper gradation of the middle tones, and less brilliant highlights, but there was some loss of speed in the threshold region despite which, however, the negative gradation was excellent for portraiture.

Another test was made with a subject having the wide brightness scale, measured from the subject, of more than 100. One set of negatives was developed in the pyro developer, with conventional proportions, another in the same developer but with the carbonate cut to 15 drops per liter of mixed developer. Equal contrast for both sets of negatives necessitated 2 3/4 hours developing time for the modified pyro bath. All negatives were printed on Convira No. O paper, those developed in the weakly alkaline solution giving better print shadow detail and more brilliant highlights, though at the cost of heavy pyro stain and a loss of film speed equivalent to between one and two lens stops

Pictures in Shade

One of the most frequent complaints we hear from beginners is that the negatives they exposed in the shade or on cloudy days when the lighting lacked contrast, were woefully flat. A simple case of cause and effect: flat lighting, flat picture. But there is a remedy. Develop such negatives a bit longer than you do those exposed under normal lighting conditions. Length of development determines extent of contrast, remember.

Imagination in Portraiture

This is going to be an indoor summer, someone recently said, in view of the growing restrictions on outdoor photographers That means more portraits than we ever did before. But let's use our imagination a little and get away from the beaten paths whenever we can. Not all subjects will lend themselves to such treatments as that used here; many an effective portrait has been achieved with more or less conventional poses, the subject itself frequently being striking enough without the employment of tricks and devices. But sometimes it's good to let yourself go, even though it may look a little crazy.

"The Duke di Verdura"

In the portrait of "The Duke di Verdura," by George Platt Lynes, fashion and portrait photograper of New York City, the latter wanted to get something different when he invited his friend in for a sitting. Animation in a still is difficult, but that was the photographer's objective. He achieved it by a very simple arrangement. The subject, astride a bent sheet of linoleum and with a strong light behind, raised his hands as if balancing himself The resulting shot, informal, gay and completely natural, pleased all.

Perspective on the Beach

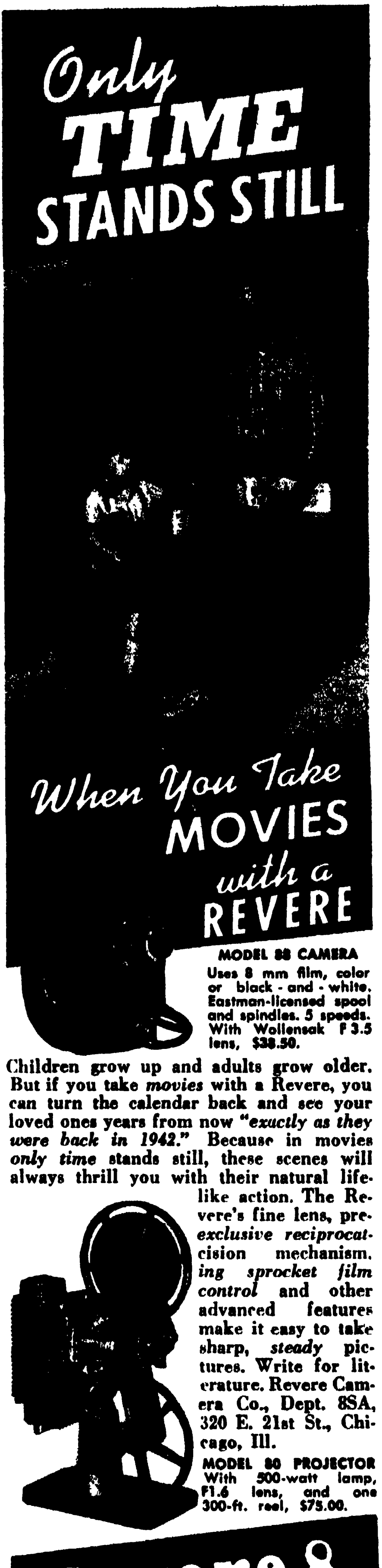
Something a little different in the way of beach pictures is this purely candid shot of two bathers in lively conversation.

A good story

By moving fairly close to the figure in the foreground and angling the camera to enclose the laughing face in the triangle formed by the extended arm and inclined head of the girl in front, a feeling of nice perspective is achieved. Stopping down to f/16 gave sharpness

Rainbows Grounded

Rainbows do not all exist in the sky. Under suitable circumstances, they descend to earth as well. Once we witnessed the phenomenon when a garage employe was spraying an automobile in the course of giving it a thorough washing. Another time we saw the same thing happen in a public park when the bright sun, as in the other instance, hit the fine drops gushing forth from a revolving garden sprayer at just the right angle, from the onlooker's point of view, to exhibit a beautiful rainbow curved in a quarter circle. Thus, the humble mortal had a close-up view of what happens in the sky: the colors of the spectrum, in the shape of a bow or arc, are formed opposite the sun by refraction and reflection of the sun's rays in drops of rain. Similar phenomena occur in spray and mist, we see. As in the sky, the grounded rainbows can be recorded in color on color film in a camera. Even pictures made in black and white will give at least a rough approximation.



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Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

LAST month in this department, R. M. Watrous, M.D., Highland Park, Ill., described a spectroscope of the concave grating, Rowland type, which he made as a follower of the amateur optical hobby, and now, in Figure 1, is a series of spectrograms which give a better idea of the refined capabilities of such an instrument than the ones he had available at that time. The spectrogram is enlarged four times from a portion of film on which are registered ultra-violet spectra extending over that part of the ultra-violet from wavelength 3100 angstroms down to 2500 angstroms. The light which made these lines is completely invisible to the eye.

The top spectrogram was made with light from an arc between ordinary cored carbons such as are used for some kinds of lantern slide projectors. Those below it were obtained by melting bits of common metals (tin can strip, tinfoil, solder, galvanized iron, brass, copper, sterling silver, silver solder, aluminum, iron) in the heat of the arc, thus causing them to vaporize and emit their characteristic wavelengths. Some of these metals did not remain in the arc long enough to record their spectra.

Since the carbons used were not of the high degree of purity required for spectrographic analysis, the lines of the elements in the core (silicon, bismuth, and magnesium) appear in all of the spectra, and are indicated at the top by their chemical symbols. The other numbers written across the top refer to the wavelengths in angstroms.

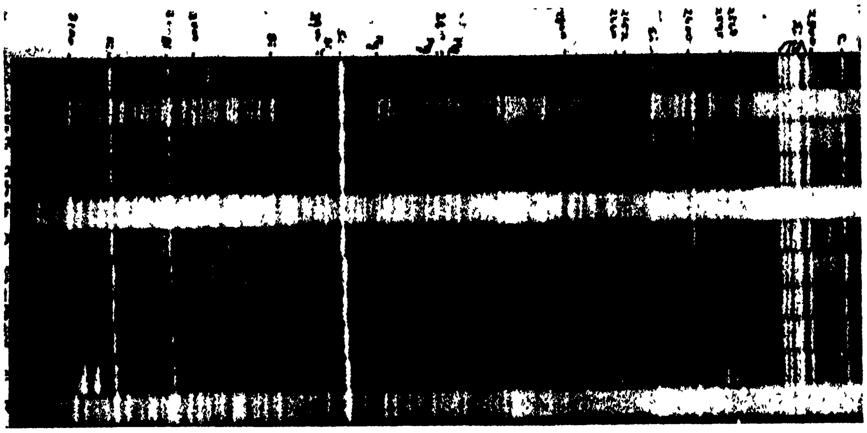


Figure 1: Spectrograms made with an inexpensive home-made spectroscope

IN THE concave grating type of spectroscope mentioned above and described last month, the slit, the grating, and the spectrum, all three, lie on the circumference of a circle whose diameter is equal to the radius of curvature of the grating. How a really large—gigantic, in fact—instrument of this type shapes up is shown in Figures 2 and 3. This is the world's second largest spectrograph, 30 feet in diameter, and is at the University of Chicago. It took over a year to build, and in size it is rivaled only by a similar spectrograph at the Massachusetts Institute of Technology. The diffraction grating, in addition to focusing the light, breaks it up into its component wavelengths and fans it out over the 40' of photographic plate.

The physics department at the University of Chicago began making diffraction gratings under the supervision of the late Dr. Albert Michelson, and after Dr. Michelson's death, in 1931, the work was continued under Dr. Henry Gordon Gale. From five to ten of these gratings have been made every year by the University and sold to scientific laboratories in all parts of the world. Only at the Johns Hopkins University are gratings made which compare, in their power to separate the spectrum lines, with those made at the University of Chicago. The grating consists of an octagonal piece of speculum metal on which vertical lines have been ruled by a ruling engine, the time required being approximately two weeks.

The giant spectrograph fills a room 40' square. A light beam from the compound to be studied originates in apparatus outside the room, passes through a narrow slit at the point in the photograph (Figure 3) to which Professor Robert S. Mulliken is seen pointing, travels across the room, strikes the grating at which Miss Jane Hamilton, a graduate student in physics, gazes (this grating is shown in Figure 2), and then is reflected to different parts of the big circle as a large fan of light. This light impinges on the photographic plates in a strip 2" in width and 40' in length, arranged in a large semicircle 30' in diameter. (The inner circle in the right half of Figure 3 is the vestige of an older and smaller spectroscope of the same type.) The photographic plate is composed of 26 sections, each 18" in length. The sections are removed separately for developing in the neighboring darkroom. It takes from three to 40 hours to secure an adequate exposure, because the dispersion of the light greatly diminishes its intensity.

If an observer stands within the fan of light coming from the grating, and walks to different parts of the room, he can witness the differences in wavelengths of the light in various parts of the fan. At one side of the room long wavelengths will cause the grating to appear a brilliant scarlet. As the observer moves across the room the color of the grating passes from red through the

Photos Chicago Times

Figure 2: Grating part of the big spectroscope

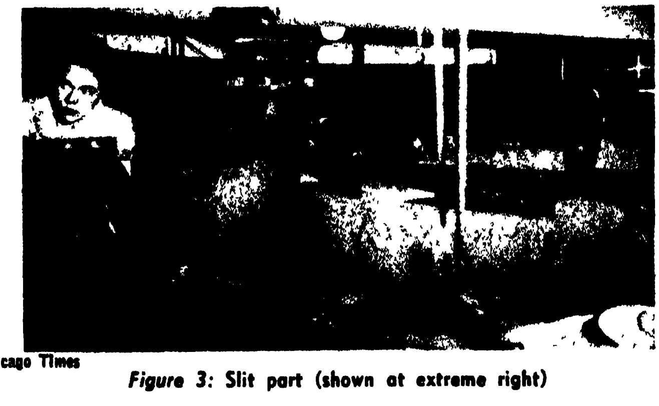
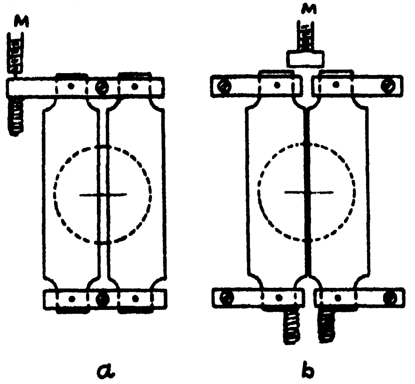


Figure 3: Slit part (shown at extreme right)

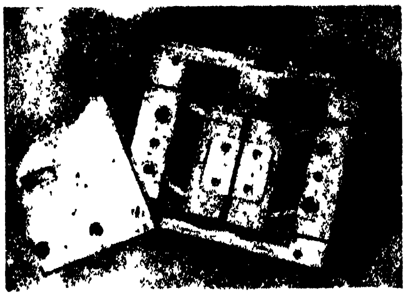
seven colors of the spectrum to violet.

Slit for spectroscopes or other optical instruments was described by Dr. John Strong, of the Astrophysical Observatory, California Institute of Technology, in *The Review of Scientific Instruments*, Vol. 12, pages 213-214, as follows:



Courtesy "The Review of Scientific Instruments"
Figure 4: Non-uniform-speed slit

"Many types of slits have been used for optical instruments. (See H. Kayser, *Handbuch der Spektroscopie*, Vol. 1, p. 532). Among them one bilateral slit which we may term the parallelogram slit, and which is diagrammatically illustrated, in Figure 4(a), has several noteworthy features. When it is skilfully constructed, this slit is both simple and effective. The opening of the parallelogram slit exhibits an adverse non-uniform relationship to the amount of turn of the adjusting screw: The slit opening changes most rapidly when the slit is nearly closed whereas we would prefer, to have a more delicate control, that the slit opening change slowly when the slit is nearly closed and rapidly when it is nearly open. Figure 4(b) represents diagrammatically the principle of the parallelogram slit adapted to achieve this desired end and Figure 5 illustrates how we apply this principle in practice.



Courtesy "The Review of Scientific Instruments"
Figure 5: Same slit in perspective

"Figure 5 is a sketch by Mr. R. W. Porter drawn from one of the slits of a new spectrometer under construction here. The cover plate, with the slot for illuminating the slit, is shown turned to one side. This plate is secured by screws in the four corners while the slit, as a whole, is fastened to the spectrometer by four other screws, two on the right side and two on the left.

"The micrometer screw displaces the slit jaw assemblies equally in a direction

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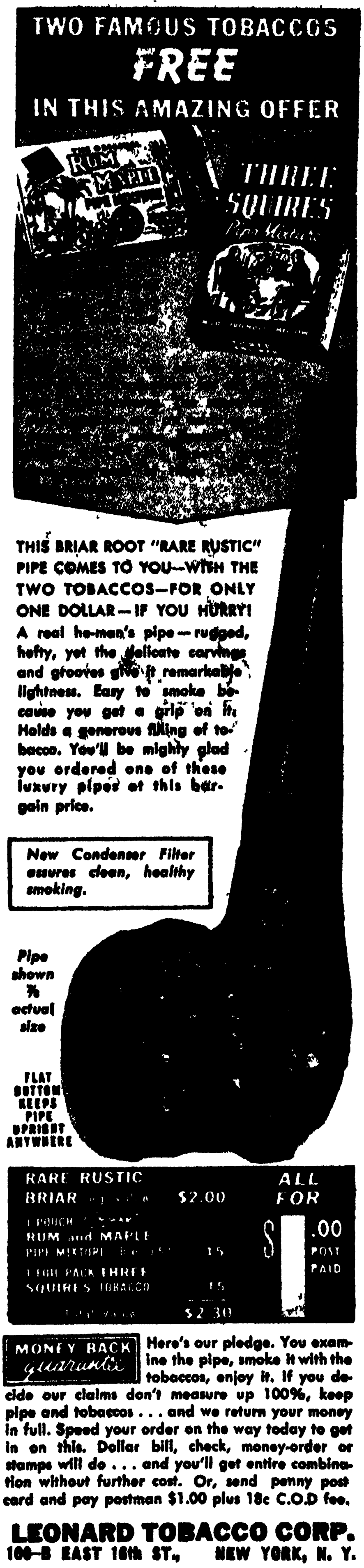
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parallel to the slit and, by virtue of their 0.006" clock spring mountings, this displacement causes the slit jaw assemblies to separate and the slit to open. Two helical springs locate the jaw assemblies definitely against the hardened end of the micrometer screw. The carefully worked slit jaws are adjustably fastened to the jaw assemblies so that the jaws will close exactly.

"The advantages of this type of slit over other types are: that the jaws cannot possibly be jammed; that the slit opening is delicately controllable when the slit is narrow; and the spring mounting, as contrasted with mounting in ways, provides a definitely reproducible mechanical system. Disadvantages are: the non-uniform relation between micrometer screw setting and slit opening and certain limitations on compactness of construction. The slit is relatively easy to construct in such a manner as to yield high accuracy.

"The slit opening is given, approximately, by the expression:

$$S=2L\ [1-\cos\ (M/L)],$$

where L is the free length of the clock springs and M is the displacement of the micrometer screw from the closed position. For the slits already constructed $L=1$ cm and $M=3$ mm giving S approximately 1 mm. The slit jaws are 24 mm long while the useful length of slit is 12 mm. The over-all dimensions of the slit exclusive of the micrometer head are 3½"x3"x¼"."

ANOTHER spectroscope—in fact, a spectrometer—made by an amateur is shown in Figure 6. F. P. Smith, Box 364, Ventura, California, is the maker, and he says he has followed spectroscopy as a hobby for 16 years and found it to have unlimited fascination and possibilities. "The concave grating type is the easiest," he writes, "also the most practicable to build. Gratings in the original can be obtained with a 2" ruling and 25,000 lines per inch at $50 to $150. About $75 will build an instrument having excellent dispersion. A very good slit can be made without machine tools, the practice it gives in filing also being of value.

"In the photograph (Figure 6), the screw which is used to oscillate the cylinder, or drum, is grooved and the groove moves the eyepiece across the spectrum as the handscrew is turned. The spiral strip on the drum is calibrated in angstrom units; it also carries the symbols of the principal lines of the elements. Thus, if 15 or 20 elements are present, the user gets a line on the crosshair and then refers to the drum.

"The camera part is at the extreme right. The round white spot is the handscrew which is used to oscillate the grating."

Figure 6: Smith's home-made spectroscope with calibrated drum

Smith's description was shown to Watrous, who replied: "This apparatus is undoubtedly more accurate than mine, though probably more difficult to build. The more expensive gratings must give much better definition."

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VIRTUALLY completed is the great mounting for the 200-inch telescope in California—our cover picture this month—but at least a year's work remains to be done to complete the mirror However, both are now "put away in mothballs"—work entirely suspended—for the duration. The photograph is by George Herbig of the Griffith Observatory in Los Angeles. See also page 142

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OUR *Point* OF VIEW

A FLASH OF GENIUS

Strange things often happen in court, but seldom if ever has a stranger theme been dwelt upon than that which the Supreme Court of the United States brought forth in a recent decision in a patent case Neither the facts of the case nor the merits of either side are of any moment here, so they can be passed by. The meat of the decision, as far as the possible future of patent law is concerned, is contained in the statement by the court that the test of patent validity is whether or not the alleged invention reveals a "flash of creative genius."

A "flash of creative genius"! Upon such a basis practically every patent ever issued in the United States or elsewhere would be invalid. Classic is the tale of Edison's long and heart-breaking search for a material from which to make incandescent lamp filaments. No flash of genius there Bell labored long and often despairingly before wires carried speech. Again no flash. Marconi created many failures before he ultimately achieved success. No flash in that. And the list could go on and on, proving that inventive genius is not given to flashes, that the patents upon which are based our great industrial world of today have been the result of much perspiration and mental anguish, seldom it ever lightened by a helpful flash

Now that we are at war, things of this sort go on every day, often passing un-noticed The pressure of war, total war, frequently warps perspective to a point where it is unappreciative of the damage that can be done by a matter that seems unimportant in the face of world-shaking events But there is a time of peace coming, a time when attention will be turned from the nerve-rending pressure of war production to the pursuits of peace Then, when our industrial machine again shifts gears, will come the realization that new ideas, reduced to practice and protected by patents, are the basis of our industrial structure If the test of a "flash of creative genius" is going to be applied to such patents, this nation is going to find itself in a horrible period of industrial stagnation This must not be allowed to happen When the period of reconstruction comes, the aid of the inventor will be needed more than it was ever needed in all the past years of technological development Upon inventions and patents will be built the new industries needed to carry on the traditions that are so much a part of the American way Let's forget about such manifestly foolish things as these "flashes" and concentrate on methods of encouraging the inventor by guaranteeing to him, even more than ever before, the fruits of his hard labor—*O D M*

SHARE THE "KNOW-HOW"

Since 1845 the pages of this magazine have been largely devoted to the dissemination of information regarding new industrial processes, new ways of doing things easier, faster, more economically, new methods of attaining new ends—in short, to spreading the "know-how"

At no time in the history of this country has there been more reason, more need, for this sharing of knowledge than there is at the present moment. Many of the larger industrial organizations are realizing this fact and are doing everything possible to spread to others, even to active competitors, news of their newest developments in many lines Reason behind all this, of course, is the war effort Everything possible must be done to increase production of the things needed to insure victory, and only by a vast pooling of information can this end be achieved in the quickest, most economical manner.

Outstanding proponent of the need for sharing the know-how is Westinghouse. By every available means that organization is spreading to the industries of the nation the story of what they are doing and, where it can be told without revealing military secrets, how they are doing it Much of this story has appeared in the pages of Scientific American, and that it has been welcomed by many readers is evidenced by our correspondence.

We have mentioned only one example; there are dozens of others, but still not too many, still not even enough The job that is being done in some small plant that no one ever hears of outside the four walls of the shop may be just as interesting, just as informative, just as important to other industries as it is to that small plant. And, too, it may have an equally large bearing on the success of the war effort

With all this in mind, the editors of Scientific American will welcome contributions from responsible members of industrial organizations, telling of some new method of operation, some new material that has been developed for a specific purpose but which may be adaptable to other uses, some new operation performed with an old tool—anything, in fact, that will contribute materially to sharing the know-how We cannot, of course, promise to publish all contributions Each one, however, will be carefully considered and its value to the greatest number of readers will be accurately weighed in the editorial balance.

The door is open, the welcome mat is out. Here is your chance to share your know-how for the greatest good of the greatest number.—*A P P.*

LIGHTER THAN AIR

Although not much information about their operations appears in the press, it is an open secret that blimps are playing a large and important part in the "Battle of the Western Atlantic" While, at the time of writing, we are still losing many surface vessels to the predatory packs of submarines that infest our eastern coast, the so-far unwritten record of achievement of these versatile lighter-than-air craft is apparently an inspiring one Where the blimp holds the advantage over the patrol plane is in its slow speed that permits more careful inspection of the water below and its ability to hover over one spot for almost any desired length of time

Perhaps the good work of the blimps influenced to some extent the recent action of Congress in authorizing an increased appropriation for lighter-than-air craft. In any event, we are going to hear a lot more about this type of aerial transportation in the near future.—*A.D.R., IV*

50 Years Ago in . . .

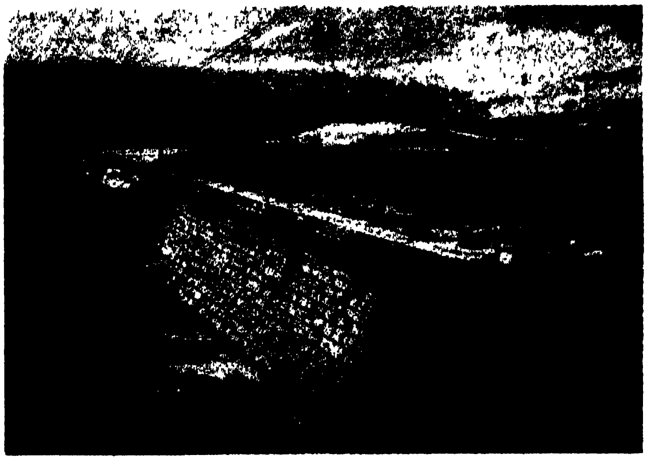
SCIENTIFIC AMERICAN

(Condensed From Issues of September, 1892)

RUBBER—"Copper salts have an injurious effect upon India rubber. . . . Metallic copper in contact with rubber causes oxidation and hardening of the gum, although no appreciable amount of the metal enters into it. Zinc does not in any way affect the rubber Oil containing even small amounts of copper coming in contact with rubber goods is highly injurious. . . All oils, except castor oil, exert a detrimental effect upon rubber."

TRIPLE SCREWS—"The fastest of the vessels of our new navy, the Columbia, will have a speed of 21 knots, with a possibility of doing 22 knots. She will, to do this, have greater horse power than any vessel ever before built in America, and is, with one exception, the first large vessel ever built with triple screws."

AUSTIN DAM—"There is being built across the Colorado River at Austin, Texas, a massive granite dam, the object of which is to furnish the city with water works and electric light, and to also furnish manufacturing enterprises with cheap water power This wonderful structure is 1,200 feet in length, and 60 feet high. It is 16 feet thick at the top, increasing downward and spreading out in a broad toe or apron, making its extreme width at the bottom 50 feet. . . . The water will be drawn from the penstocks through iron pipes, pass the wheels, fall into the wheel pits, and be discharged through underground races into the river. There will be three water wheels, forty-five inches in diameter, each capable of giving 600 horse power on a head of 60 feet . . . During the flood season the amount of water that will flow over this dam, it is estimated, will be 200,000 to 250,000 cubic feet per second, which is nearly equal to the volume at Niagara Falls."



INVENTION—"No argument is needed to show that to invention must be accorded a very high place among instrumentalities for promoting progress, but some believe that no new principles remain to be discovered, and that there is little if any unknown material; therefore, they say, great inventions in the future must necessarily be few. Such is the argument of the pessimist, which at first may seem rational, but seen in the light of modern progress must give way to the opposite view, which holds that every new discovery or invention is almost sure to lead to other discoveries and inventions of equal or greater importance; that we are only on the borders of the realm of invention, and that the possibilities of the future are far greater than those of the past. This is the optimist's view, which is backed by history, reason, and common sense."

PHOTOGRAPHERS—"Professional photography at the present time is admittedly not in a flourishing condition, and the causes commonly assigned for the depression include, of course, bad trade, severe competition, and the influence of the once despised but now potent amateur."

WOODEN—"The sailing ship Roanoke, launched at Bath, Me., lately, is said to be the largest wooden ship afloat Her length is 311.2 ft.; breadth, 49.2 ft.; depth, 29.2 ft.; gross tonnage 3,539."

VOLCANOES—"Tropical America presents some of the most superb volcanic spectacles in the world. In Ecuador are twenty volcanoes from 16,000 to 22,500 feet high, eighteen of them being crowned with eternal snow, and eleven never having been scaled by any living creature. Fifty more exist in the Central American region, and twenty-one in Mexico, chief of which is the lordly Popocatapetl."

SPARK PHOTOGRAPHY—"Professor Vernon Boys lately explained that by the electric spark articles moving at the rate of 10,000 miles an hour can be photographed, and by the introduction of a revolving mirror a speed of 180,000 miles an hour can be coped with. The mirror makes 1,024 turns every second, worked by electricity, which is equal to about 150 times as fast as a rifle bullet travels. The whole photographic power of the spark is over in a time equal to the ten or eleven millionth part of a second, and it is during that incredible brief space that the image is made on the sensitive plate."

RAILROADS—"According to the *Street Railway Review*, there are now nearly 1,000 street railway companies in the United States, of which fully 400 are electrically operated, in whole or in part "

PYRAMID BUILDERS—"A two years' study at Gizeh has convinced Mr Flinders Petric that the Egyptian stone workers of 4,000 years ago had a surprising acquaintance with what have been considered modern tools. Among the many tools used by the pyramid builders were both solid and tubular drills and straight and circular saws. The drills, like those of today, were set with jewels (probably corundum, as the diamond was very scarce), and even lathe tools had such cutting edges. Of the . . . method of making the tools nothing is known."

TELEPHONE—"In speaking of the future of the telephone, Professor A. Graham Bell says: 'The telephone, as at present constructed, needs the open air to obtain the best results. To use wires placed underground, a metallic circuit will be necessary, similar to the one used now on long distance lines. To place the wires under ground and to make a metallic circuit, which means to use two wires where one is used at present, will materially increase the expenses of the company, and the public must pay for the luxury. As the number of wires is increasing rapidly, it is evident that they must ere long be buried.' "

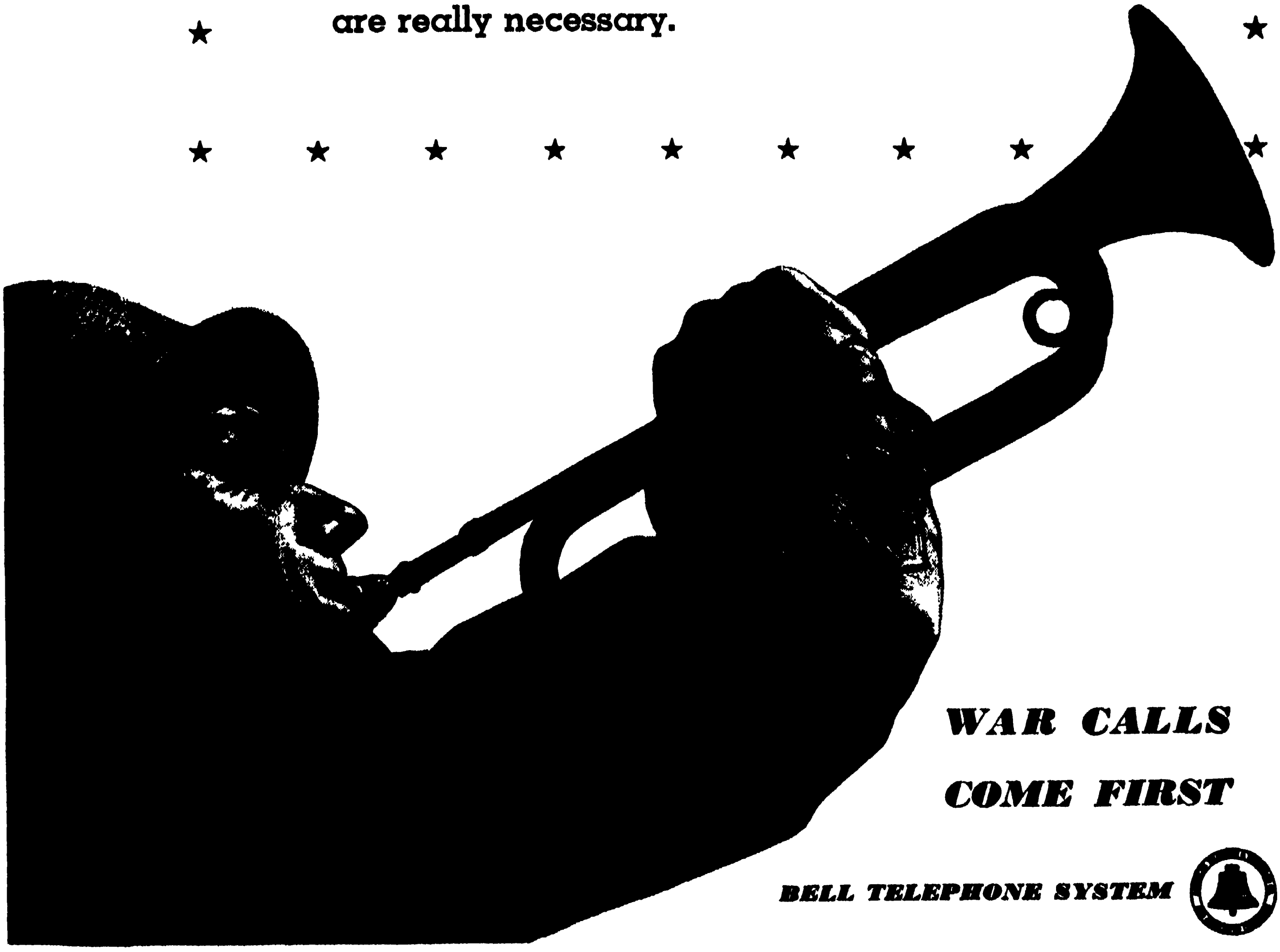
Clear the Lines for the War

Before you make a Long Distance telephone call today, ask yourself these questions:

1. Is it necessary?
2. Will it interfere with war calls?

The weight of war on the telephone lines is heavier every day. We can't build the new lines to carry it because sufficient materials aren't available. We've got to make the most of the service we now have.

Please give a clear track to the war effort by confining your Long Distance calls to those that are really necessary.



WAR CALLS COME FIRST

BELL TELEPHONE SYSTEM

98TH YEAR SCIENTIFIC AMERICAN SEPTEMBER 1942

NAVAL INDISPENSABLES

Cruisers Can Perform a Wide Range of Missions

WALTON L. ROBINSON

● **Third article of a series on the ships of the United States Navy. The next, dealing with destroyers, is scheduled for October publication. Former articles were on battleships and carriers and were published in May and August.—*The Editor.*** ●

Aside from battleships and aircraft carriers, cruisers are the largest, costliest, and most formidable type of naval vessel. But unlike carriers, which are not, strictly speaking, combatant units, cruisers are fighting ships in every respect. Well armed and fast, they can perform a wide variety of missions. Their presence with the battle fleet in a major action is essential for scouting duties, for supporting destroyer attacks on the enemy, and for repelling hostile ones. Cruisers are also indispensable components of the carrier striking groups which have become such an important and spectacular feature of the aero-naval warfare in the Pacific, while on detached service they can operate very effectively as commerce raiders or as escorts to valuable merchant ship convoys. Most modern cruisers displace from 5000 to 10,000 tons, are armed with six to fifteen 6-inch guns or six to ten 8-inch weapons, and have a speed of 32 to 35 knots. Some of them, particularly those designed for very high speeds have less armor protection than battleships, but the majority do have armored water-line belts, armored decks, and plating on the gun-houses.

The United States Navy is very well provided with cruisers. At the time of the Japanese attack on Pearl Harbor we had in service 18 "heavy" cruisers armed with 8-inch guns and 19 "light" cruisers mounting 6-inch weapons. Six additional light cruisers, four of them of an entirely new design and carrying 5-inch guns, had been launched and were rapidly nearing completion. One of the 5-inch gunned ships, the 6000-ton ***Atlanta***, was commissioned before the end of the year. Fifty other cruisers, including six huge units of some 25,000 tons each, were under construction or on order.

Our 37 heavy and light cruisers ready for sea on the outbreak of war had an aggregate displacement of 329,550 tons and mounted a total of one hundred and eighty-four 8-inch and two hundred and forty-five 6-inch guns, giving us a cruiser force second only to Britain's in all-'round fighting strength. Japan, with at least 40 modern cruisers, enjoyed a slight numerical superiority over us, but the Nipponese ships were generally smaller and less powerfully armed than ours. They displaced some 285,000 tons and carried one hundred and four 8-inch, one hundred and forty-four 6.1-inch, and one hundred and twelve 5.5-inch guns.

America's oldest cruisers are the ten still very serviceable units of the 7050-ton *Omaha* class. They were ordered in 1916-19 and the *Omaha* and *Milwaukee*, laid down in December, 1918, entered service in 1923. The remaining ships, begun in 1920, were completed in 1923-25, the *Memphis*, last of the class, being commissioned February, 1925. All of them originally had a main armament of twelve 6-inch, 53-caliber guns firing a 105-pound shell at a maximum range of some 22,000 yards, or about 13 miles. In recent years, however, two 6-inch guns were removed from the *Cincinnati*, *Detroit*, *Marblehead*, *Raleigh*, and *Richmond*, and these ships now carry only ten guns. The *Concord*, *Memphis*, *Milwaukee*, *Omaha*, and *Trenton* still retain their original armament.

Until recently the anti-aircraft battery consisted of four 3-inch guns (six in the *Concord*) and eight machine guns, but this has now been considerably increased. Six torpedo tubes firing 21-inch "tin fish" complete the *Omahas'* offensive power, while several planes add immeasureably to their range of vision when engaged on scouting missions. In normal times only two aircraft are carried, but four can be accommodated when desired. Two catapults are provided for launching them into the air. Armor protection includes a 3-inch water-line belt and a 1½-inch deck over engine and boiler spaces.

Westinghouse, Curtis, or Parsons geared turbine engines driving four propellers and developing 90,000 horsepower, give the *Omahas* a designed speed of 35 knots. This speed, however, can only be maintained for brief periods and then with considerable difficulty. Oil fuel capacity is about 2000 tons, sufficient for a cruising radius of some 10,000 miles when the ships steam at their most economical speed (15 knots). At 20 knots their radius of action drops to around 7000 miles, and at 30 knots to some 3000 miles.

The *Omahas* were our Navy's only modern cruisers throughout the 1920's or until the completion early in 1930 of the *Pensacola* and *Salt Lake City*. The construction of these two ships, together with that of six other cruisers, was authorized late in 1924. It was decided that all of them should be of the largest size (10,000 tons displacement) and mount the heaviest guns (8-inch) permitted by the Washington Naval Treaty of 1922.

The *Pensacola* and *Salt Lake City*, laid down in 1926 and 1927 respectively, were ready for service early in 1930 and, following their "shake down" cruises, joined the Scouting Force, U. S. Fleet. Although designed to treaty limits, their actual displacement is only 9100 tons. With their ten 8-inch guns they are, however, among the most powerfully armed

U S Navy Official Photo

Cruiser *Atlanta*, believed to have extraordinary armament

cruisers in the world. These guns, 55 calibers in length, elevate to 45 degrees and hurl a 250-pound shell They are grouped in two triple and two twin mounts, the former being in the superimposed positions The anti-aircraft battery, which for some years consisted of four 5-inch, 25-caliber guns, was recently increased, details, however, are restricted. Six 21-inch torpedo tubes were originally carried, but were removed in order to provide space for additional anti-aircraft guns.

A 3-inch belt of armor along the water-line and two decks, 1 and 2 inches thick, protect the vital engine and boiler rooms, while 1½-inch plating is on the face of the 8-inch gun turrets Four planes and two catapults, mounted between the funnels, give these cruisers a wide range of vision

Designed speed of 32.7 knots is obtained by geared turbine engines developing 107,000 horsepower and driving four propellers. Steam is supplied by eight boilers with a working pressure of 300 pounds per square inch. Radius of action is some 13,000 miles at 15 knots These engine- and boiler-room data apply generally to all of our heavy cruisers except the new *Wichita*.

Flush decked, the *Pensacolas* suffer from lack of freeboard (height of deck above water-line), and roll at low speeds, but are remarkably steady when steaming at 20 knots or more. The greatest economy in weights was practised in their construction, aluminum alloy internal fittings replacing steel wherever possible. Electric welding instead of riveting was also employed extensively

The six ships of the *Northampton* class, all laid down in 1928, followed the *Pensacola* and *Salt Lake City* into service in 1930-31 Differing in minor details, their displacements ranged from 9050 to 9300 tons. One of them, the *Houston*, was flagship of Admiral Thomas C Hart, Commander in Chief, Asiatic Fleet, on the outbreak of war and was sunk by the Japanese during the night of February 28-March 1 in Sunda Strait, between the islands of Java and Sumatra Her sister ships are the *Northampton, Chester, Louisville, Chicago,* and *Augusta*

These cruisers have exceptionally graceful lines and are a considerable improvement over the *Pensacolas,* from which they differ markedly in distribution of armament and general design They carry nine 8-inch guns disposed in three turrets, two forward and one aft, and originally had four 5-inch anti-aircraft guns. Torpedo tubes were removed several years ago and the additonal space thus made available was devoted to increased defense against air attack Armor protection is much the same as in the *Pensacolas.*

Instead of a flush deck, the *Northamptons* have a raised forecastle deck, while a spacious hangar, accommodating from four to six planes, is located just forward of the second funnel Two catapults, on high mounts, are immediately in front of the hangar The *Chicago* and *Augusta*, specially fitted as flagships, have their forecastle extended aft to the catapults in order to secure the extra accommodation required.

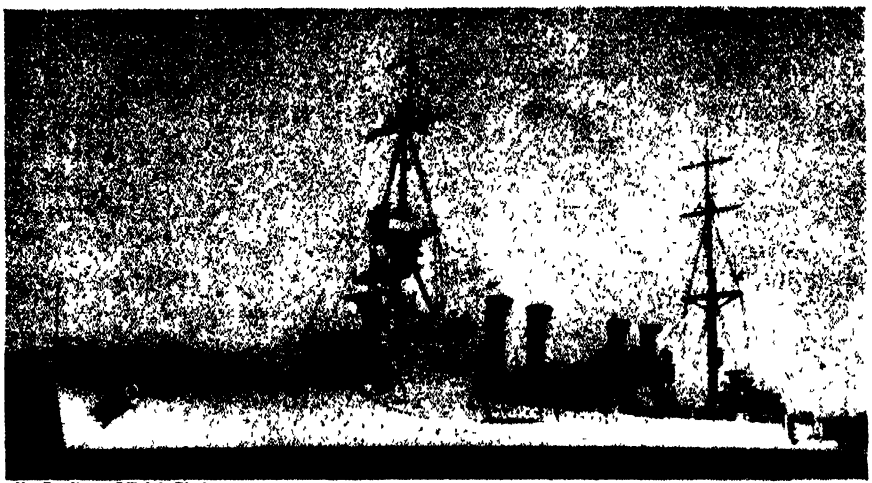
In 1930 two more heavy cruisers, the 9800-ton *Portland* and 9950-ton *Indianapolis*, were laid down, having been authorized the previous year Completed early in 1933, they are simply a development of the *Northampton* design with alterations in weight distribution to improve stability The height of their masthead fire-control top is lower by 30 feet, but their bridges are higher and have some 40 tons of armor plating spread over them Eight 5-inch anti-aircraft guns are carried No torpedo tubes were included in the design. Aircraft-handling arrangements are as given for the *Northamptons*. The *Indianapolis* is fitted as a flagship and can be distinguished from the *Portland* by her longer forecastle

In 1930-31 the keels were laid for five new cruisers: the 9950-ton *Astoria, Minneapolis, New Orleans, San Francisco,* and 9975-ton *Tuscaloosa.* All were launched in 1933 and completed the following year. Two more units, the 9375-ton *Quincy* and 9400-ton *Vincennes*, begun in 1933-34, entered service in 1936-37. These seven ships are of an entirely new design, differing radically in appearance and defensive qualities from our older heavy cruisers. Their forecastle has been extended to the second funnel with a slight reduction in freeboard, bow form altered; light pole masts substituted for heavy tripods; bridges raised; anti-aircraft guns re-distributed; and plane catapults and hangar moved aft, the latter extending to the shelter deck. Their armament is identical to the *Portlands'* but protection is much stronger, consisting of a 5-inch water-line belt, 3-inch and 2-inch decks, an 8-inch conning tower, 5 to 6 inches on the gunhouses, and plating on the bridges.

Our latest heavy cruiser, the 9324-ton *Wichita,* laid down in October, 1935, and completed three and one-half years later, was originally to have been a unit of the *Astoria* class. As completed, however, she differs as much from the *Astorias* as these ships differ from the *Portlands*. The *Wichita* is, in reality, a heavy cruiser version of the *Brooklyn* class of light cruisers She has a flush deck with a high freeboard and a square stern. Her armament comprises nine 8-inch guns disposed in the conventional manner and eight 5-inch aircraft weapons, two of which are mounted fore and aft in super-imposed positions above the 8-inch gun turrets. Armor protection is about the same as the *Astorias'* but plane-handling arrangements are utterly different. The hangar, which is located below decks in the extreme stern, can accommodate as many as eight aircraft.

The *Wichita* is powered by Westinghouse geared turbines developing 100,000 horsepower and driving four propellers. Her designed speed is 32.5 knots, which is slightly below that of any of our other heavy cruisers.

In the years 1934-39 nine large, powerfully armed, and stoutly protected light cruisers were laid down and completed for the U. S. Navy. They were a direct "reply" to the 8500-ton Japanese cruisers of the *Mogami* class, armed with fifteen 6.1-inch guns. The *Brooklyn, Philadelphia, Savannah, Nashville,* and *Honolulu* joined the fleet in 1938 and the *Phoenix, Boise, Helena,* and *St. Louis* followed in 1939. Their displacements range from the 9475 tons of the *Savannah* to the estimated 10,000 tons of the *Helena* and *St. Louis,* which are a slight modification of the earlier design. These cruisers mount fifteen 6-inch guns grouped in five well armored turrets disposed along the center-line and eight 5-inch and numerous smaller anti-aircraft weapons.

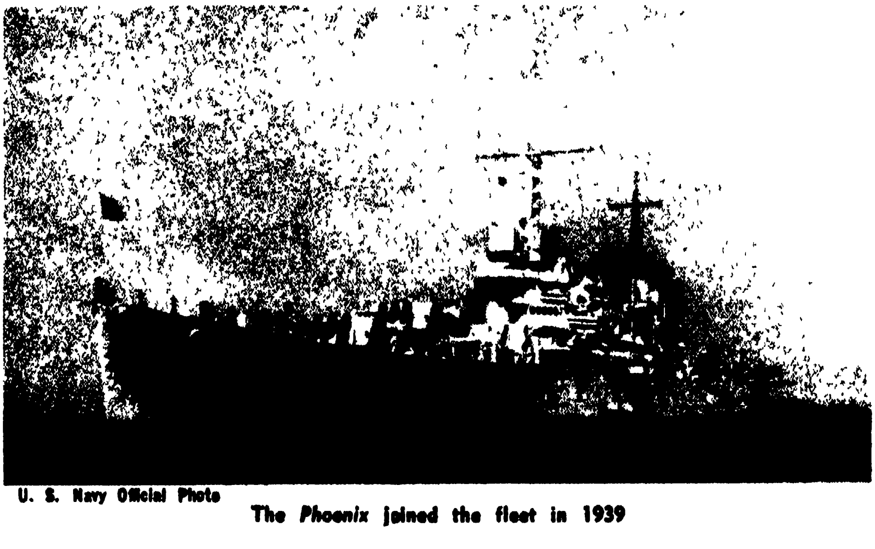


U. S. Navy Official Photo

The *Memphis:* She still retains her original armament

America's newest light cruisers are the 6000-ton *Atlanta, Juneau, San Diego,* and *San Juan.* Laid down in 1940 for completion in 1943, they are now entering service—a splendid example of how our shipbuilding has been stepped up. The *Atlantas,* whose design incorporates many novel features, are apparently intended to operate as leaders of destroyer flotillas and as fleet anti-aircraft escort ships. They are the fastest American cruisers ever built.

The *Atlantas* are believed to mount an extraordinary armament: sixteen 5-inch, 38-caliber "dual purpose" guns which can be used effectively against aircraft as well as warships. These guns are believed to be disposed in eight twin turrets, three forward and three aft on the center-line and two aft on the main deck, one to port and the other to starboard. The center-line turrets are super-imposed one above the other. The anti-aircraft battery proper is believed to consist of twelve 1.1-inch pompoms in three quadruple mounts on platforms, two forward on either side of the bridge and one aft between the after fire-control tower and the topmost super-imposed 5-inch gun turret. These pompoms, together with a half-dozen heavy machine guns, will be employed against low-flying aircraft such as dive-bombers and torpedo planes. Eight 21-inch torpedo tubes in quadruple mounts complete the offensive power of these remarkable ships. On trials, speeds in excess of 40 knots have been attained.



U. S. Navy Official Photo

The *Phoenix* joined the fleet in 1939

Of our 52 cruisers under construction or on order, 32 are of the *Cleveland* class, modified *Brooklyns* with a probable armament of twelve 6-inch guns; eight of the *Baltimore* class, 13,000-ton editions of the *Wichita* design with stronger anti-aircraft batteries and greater armor protection and cruising range; six of the *Alaska* class, "mystery ships" reportedly displacing some 25,000 tons and officially designated "large cruisers"; and four additional units of the *Atlanta* class. The two remaining cruisers, authorized last December under the 5 percent increase in the two-ocean Navy, will probably belong to one of the above groups.

Many of these cruisers are scheduled for completion this year. Their entrance into service should influence greatly the course of the war at sea, for our Navy will then be able to provide stronger escorts for convoys in the North Atlantic and Pacific and strike telling blows at Japan's vital bases and extended lines of communications.

Domestic Rubber 'Plantations'

Scrap Rubber, Reclaimed, Can Go Far to Fill the Gap in Military and in Some Civilian Needs

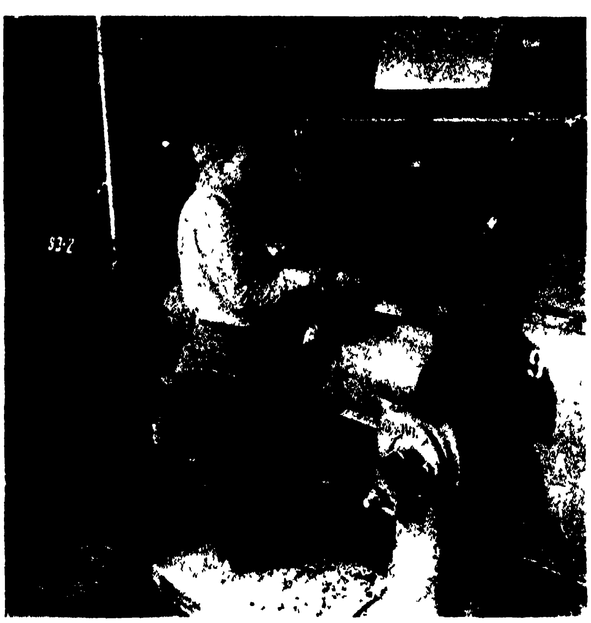
A. P. PECK

THIS business of reclaiming various types of manufactured rubber objects and putting their basic material back into the channels of trade is not so new as the recent publicity on "rubber drives" might lead one to believe. Since shortly after the very beginnings of the rubber industry, much attention has been put to reclaiming the rubber in objects which have served their original purpose. (A brief paragraph on the reclamation of rubber appeared on the "50 Years Ago" page in Scientific American in our issue of May 1942.)

During the past few months we have heard much about three different "kinds" of rubber · Natural rubber, synthetic rubber, and reclaimed rubber That there will be little or none of the first of these available, so far as civilians are concerned, for the duration of the war is already an established fact. Commercial production of various types of synthetic rubber is already underway but on a relatively small scale; it will be at least a year if not longer before this production approaches a point where it can start to satisfy even the immediate needs of the military forces. There is little hope that any synthetic rubber will be available for civilian purposes for a considerably longer period of time.

This leaves reclamation as the one source from which civilians may hope to get at least a part of the rubber products which are essential to everyday life and, as newspaper publicity has so well told, the amount of reclaim that will be available depends largely upon Mr. and Mrs. John Citizen themselves and on the continuing response which they make in supplying the objects from which reclaim can be obtained.

Actually, the reclaimed rubber industry is by no means the ugly duckling that its name might seem to indicate. Reclaim itself, furthermore, is certainly no object of scorn, particularly in these days of economic stress. For many years it has served an honorable array of purposes in the rubber goods market, without public fuss or fanfare. The fundamental fact to keep clearly in mind is that reclaim can be used—either all by itself or in any degree of mixture with crude rubber—for the manufacture of almost anything that can be made from crude virgin rubber, but that there is always a loss in performance in the resulting process, this loss being in direct ratio to the proportion of reclaim used



Old tires, with the wire beads removed, are ground to powder, which is then routed to the digester tanks

As in all questions, there are two sides to this one There are some rubber products in which it is so essential to have the maximum efficiency of 100 percent virgin rubber that reclaim cannot enter the picture at all. Innertubes for vehicle tires are the best example of this. On the other hand, reclaim can be just as exclusive in its own field. Rubber heels and hard rubber products such as battery cases and combs are examples of products in which reclaim is actually superior to virgin crude because of various mechanical reasons.

A brief survey of the reclaiming process itself will aid in an understanding of the relationship between crude and reclaimed rubber.

When scrap rubber of any kind is first received at the reclaiming plant, it is assorted according to its present form and according to the process to which it will be subjected for reclamation. Since tires are uppermost in everyone's mind today, the reclamation of them in one rubber company's plant will be taken as an example.

Before the tires start in the cycle which will reclaim the rubber content, the steel wire in the beads is removed. The tire carcass is then fed into a grinding machine where rubber and cotton fibers alike are reduced to powder. After magnets remove any small particles of iron and steel, the powder is routed to digesters where it is treated with dilute caustic soda, at high temperatures and pressures, to dissolve the fibers. This treatment, by the way, has an important effect on the quality of the finished reclaim and is varied according to the material being processed

From the digesters the material passes through a washing screen where the caustics are removed. From here it goes to the driers, where it is subjected to heat and steam pressure for eight to twelve hours before going to the mixing mill. In that mill the powder is still further ground, then washed and dried and thoroughly mixed and kneaded on steam-heated rolls.

From the mixing mill the reclaimed rubber undergoes a "straining" process where, under steam pressure, it is forced through fine screens to remove the last possible vestiges of dirt and foreign matter. From these screens the rubber emerges looking like black spaghetti

In the final step, the black spaghetti is rolled and formed into slabs for use in the manufacture of various rubber products. These slabs are soft and plastic; the rubber, however, is not restored, either chemically or mechanically, to the full power and life of virgin rubber. It still has a certain amount of bounce and resiliency, but the exact amount depends upon the quality of the material fed in at the beginning of the reclaiming process and upon the reclaiming process itself.

The reclaim still contains most of the chemicals—sulfur, carbon black, and so on—that were put into the original object when it was manufac-

The mixing mill. Steam-heated rolls knead and mix scrap being processed

tured from crude rubber. By the same token, it has a smaller proportion of the native rubber molecules. Thus it can be seen that if the reclaiming process were repeated a number of times the undissolvable foreign elements would eventually so far outnumber the rubber elements that the result would be a conglomerate mass that would be more like asphalt than rubber.

WHILE few authoritative figures are available regarding reclaim, it appears that in October 1941—note that this was before Pearl Harbor—the rubber industry consumed about 4½ pounds of reclaimed rubber for every ten pounds of new rubber. During the first World War, statistics indicate that a proportion of about 57 percent as much reclaimed as new rubber was consumed during 1917. Again, during 1928, consumption of reclaim climbed to a high of 51 percent of the crude rubber consumed, as a result of several years of high-priced natural rubber. It also appears that 1941 was the biggest year in history for the production of reclaim, with about 280,000 long tons being turned out. The total reclaiming capacity of the nation at the present time—on a 24-hour day seven day a week basis—is about 320,000 long tons a year. This production would be possible, of course, only if the flow of scrap rubber to reclaiming plants were such as to maintain that all-out operation.

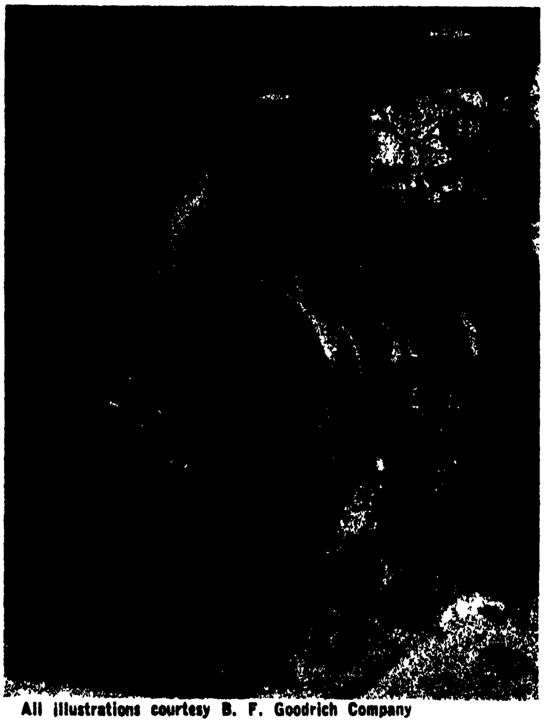
Probably what the average civilian is largely concerned with, as far as the rubber situation goes, is automobile tires. What can reclaim do to alleviate the present tire situation?

The answer at the present moment appears to be that it can't do much, if anything. In the first place, all of the rubber for tires that is obtained by reclaiming methods will undoubtedly go immediately into military, lend-lease, and other vital channels. The probabilities are that little, if any, can be spared for ordinary civilian use. Even if it could, reclaim alone is not too good for use in motor vehicle tires. True enough, there have been made for many years automobile tires in the lower price brackets which have contained sizeable amounts of reclaim. These tires have given reasonably satisfactory service but it must be remembered that they contained a relatively large percentage of crude. If, however, attempts were made—and such attempts are not even being contemplated at the moment—to make "war tires" entirely of reclaim, the use of such tires would mean re-educating the public to totally new driving habits. These tires would not give even the service of pre-war second- or third-line tires, they would have to be driven at slow speeds, and they would have to be given every consideration to prolong their inherently short service life.

Today, therefore, the most important use of reclaim, as far as tires are concerned, is in the production of wartime grades of camelback for retreading and recapping. One bright spot in the reclaim story today is the fact that present-day scrap is better than that of only a few years ago because it consists largely of rubber fortified with superior organic accelerators and with lower sulfur ratios than in earlier years. Furthermore, it is protected by anti-oxidants and the better quality of rubber products resulting from this compounding of the original crude will, of course, carry through into the product made from reclaim.

EVEN before the emergency, many articles in everyday use were (and still are) made of 100-percent reclaim. To mention just a few of them, the list would include rubber heels, floor mats, flooring, hard-rubber goods, bath sprays, jar rings, fly swatters, door wedges, weather stripping, and so on

Qualitatively, the usefulness of reclaim can be extended today as never before, according to rubber technicians. This extension will be over and above that which the war emergency would dictate, because reclaim is being produced in grades suitable to more uses than heretofore. Quality and uniformity are under much more strict control and reclaims of different types are being made to meet certain standard specifications agreed upon by the reclaimer and the consumer. Processing qualities, also, have been so improved that the proportion of reclaim used can be increased without causing difficulty in the manufacture of rubber



All illustrations courtesy B. F. Goodrich Company

Rubber from the mixing mill is "strained," emerges from machine looking like black spaghetti goods by standard methods.

Parenthetically, it should be mentioned that many new uses for reclaim are becoming highly important to the industry. One of the most recent is an extensive use of reclaim in aqueous dispersions. These dispersions might be considered as synthetic counterparts of latex, except that they may be derived from either reclaim or crude rubber. Present commercial applications of these dispersions, which are quite similar to those of latex, nearly all make use of reclaim. Such dispersions are available in various colors and compositions, varying in concentration, stability, and other characteristics. It is stated by rubber technicians that the new uses for reclaimed rubber dispersions now account for a substantial consumption of reclaim.

On bottom roller is the reclaimed rubber being rolled and made into slabs for use by the trade

Unfortunately for the process of collecting old rubber from widely spread points, it is those items that do not bulk very large that are of the most value for reclaiming. Things like hot-water bottles, crepe soles, inner-tubes, bathing caps, and so on, are almost ideal for the processing and yield the highest quality of reclaim. Bulkier things such as door mats, boots and overshoes, running board mats, and so on, are less valuable. Many of these latter, because they already have so much reclaim in them, are good only for conversion into rubber products of similar properties. Auto tire casings rate in the middle group of these extremities of scrap preferability. They are not as useful as inner-tubes and the crepe rubber soles, but they are better than door mats and overshoes. On the average, a ton of better grade scrap will produce ¾ of a ton of reclaim.

Articles of hard rubber—battery cases, combs, and the like—are not reclaimable at all. They have such a high proportion of sulfur, carbon black, and other minerals in their original compounding that the natural rubber molecules have been all but smothered.

During recent months the production capacity of the reclaim industry has been substantially increased. This has been accomplished by increased efficiency in production, coupled with high-operating rates, and by installing such new equipment as was needed to balance production throughout the plants. It appears that the reclaim industry as a whole is in a position to meet the demands of abnormally high consumption of its products, provided, of course, that the scrap material needed for processing flows into the plants in a steady stream.

[Note: At the time of going to press there is considerable discussion in Washington on the matter of tires for civilian use, composed largely of reclaim, plus a very small percentage of crude, plus relatively large percentages of synthetic rubber. It is claimed that these tires can be manufactured without interference with the supplies of needed rubber for military requirements. Nothing has been proved so far, however, and unless the situation changes materially before this issue reaches the readers, the foregoing paragraphs relating to tires for civilian use still stand.—*A P P*]

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NEW STEEL

Makes Use of No Critical Alloying Elements

In the fuselages of certain airplanes, seamless tubing of cold drawn chromium-molybdenum alloy steel is used because of its great strength. Chromium, however, is now on the critical list.

If certain experiments now well advanced in one steel company turn out to be successful, and the aircraft steel specifications are accordingly changed, another alloy steel may be used for the purpose. It contains no chromium and, indeed, requires no virgin alloying elements of any kind. The alloys used are all obtainable from scrap.

Furthermore, experimental lots of tubing, produced by electrically welding flat strips into tubular form, have proved to be as strong and dependable as the cold-drawn, seamless tubing now in use. Electric-welded tubing not only can be produced faster than seamless, but plenty of equipment to produce it is available in steel companies.

POLISHING BRUSH

Eliminates Stress Concentration Points

A new polishing brush that has the unique job of increasing the safety of fighter planes by eliminating peculiar "stress concentration points" on metal surfaces is reported to be the product of the careful analysis of 70 serious airplane crashes occurring in the United States during a period of several years.

According to R O Peterson, manager of the technical department of The Osborn Manufacturing Company, the brush is being produced in large quantities for manufacturers of airplane engines and engine parts under pressure of government demands.

After a study of the 70 crashes, scientists found they were due to failure of some moving or vibrating part in the plane, Peterson says, stating that he became convinced that the essential cause in most instances could be attributed to the existence of stress concentration points on the metallic surfaces.

"These points," reports Mr Peterson, "may be nothing more than sharp scratches or nicks on the surface, not much more than eight one millionths of an inch deep. They may be tiny burrs or grooves left in machining. When stress, especially that due to high-frequency vibration, is placed on a machine part having one of these defects, the stress is concentrated there. From one of these tiny points a crack may begin that will end in a fatal plane crash. When a crack starts, it follows along the surfaces of the crystals that make up the structure of the metal. Even if a stress concentration point is situated in the strongest portion of a machine part, this defect may be a cause of failure."

Investigators found that ordinary polishing would eliminate these points satisfactorily, if they were in accessible places, but many surface areas that required polishing could not be reached by ordinary polishing equipment. More flexible tools were required, and Peterson and his assistants at Osborn found that a brush of tampico fiber could do the work required. This met with the approval of the Army and Navy inspectors. The brushes are made in the form of cylinders or flat disks and are given a treatment with a special form of stiffening liquid to prevent their fluttering while in motion. The polishing material used with the brushes is usually a very finely powdered alundum, fine enough to go through a 240-mesh screen, and suspended in a suitable pasty material.

Brush makes fighter planes safer

The polishing accomplished by means of the brush eliminates stress concentration points much more effectively than other polishing devices, Mr. Peterson claims.

The tampico brush does not impart a luster as high as that given by other polishing devices, but the surface is much more suitable for machine parts The finish is so uniform, in fact, that a special instrument is necessary to test the irregularities. Inspection is made by a specially trained observer, who makes use of reflection to detect with his naked eye irregularities on the order of eight one millionths of an inch.

WELDS PHOTOGRAPHED

For Instruction and Inspection Purposes

A new photographic method for inspecting welding work has been developed by C. A. Dunn, Professor of Engineering at Oklahoma A. & M. College, Stillwater, Oklahoma. Airplane factories, shipyards, and many other concerns engaged in national defense work may eventually benefit from his work.

Working in co-operation with the Eastman Kodak Company, Professor Dunn found that welds could be photographed, although many difficulties were encountered in attempting to photograph such work; and that such factors as size and shape of molten pool, arc length, indication of fusion, undercutting, and so on, could be distinguished in different quality welds. The intense light produced by the electric arc necessitated the use of a camera filter. A filter permitting only 10 percent of the light to reach the film gave the best results—clear details and little glare. Color film was also tried, but the smoke from the burning electrode made a blue color to which color film was sensitive, obscuring some important details of the welding.

The automatic camera was next considered. Although Professor Dunn learned from camera experts that there was no photographic reason why a camera could not be installed in an electrode holder, as yet the design of the photo-electrode holder has not been completed.

The present phase of Professor Dunn's research is an effort to adapt sound to the picture. The sound of the arc is useful to the welder and inspector in passing judgement on the photographic process. Professor Dunn believes that the first important use of the photographic process will probably be in training courses for student welders and inspectors.—*Engineering News-Record.*

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FILLER—**A new synthetic resin binder used in knot-hole fillers has been found to increase the value of low-grade lumber and to improve high-grade lumber. Secret of this filler is that it won't shrink even when used in two-inch diameter knot-holes.**

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TOUGH STEEL

Armor Plate Almost Wrecks Plant

Steel men enjoy licking tough jobs The men in one company are especially proud of one completed job that was such a downright bad actor that for a time it threatened to wreck completely a vital piece of equipment.

The order was for a special type of armor for one of our allies—a grade of steel never before made in this country. The steel was urgently needed, so any prolonged experimentation in manufacturing methods was out of the question.

No particular difficulty came up in the process of melting the steel and meeting the specifications for chemical composition, but then the trouble started.

The steel proved to be so hard and tough that from the outset it appeared that the rolling mill would have to be operated at only one fourth its usual speed. Even that did not solve the problem, however.

As an ingot would enter between the two rolls of the mill, there would be a deafening crash, the great rolls would shudder, slow down, and finally break—disabling the mill. A new set of rolls would be installed, the speed of the mill cut still further, the amount of pressure on the ingot reduced, and the mill crew would try again—and shortly break another roll.

This kept up until the plant was down to its very last set of rolls. By that time, most of the company's top-flight production men had been mobilized for the job and they were able to figure out a proper combination of mill speed, pressure, and the various other rolling factors. On the last set of rolls available, they were able to complete the order.

• • •

WARPING—**Plywood panels constructed so that they have nearly the same stiffness in directions with and across the face grain are much less apt to warp than panels which are very limber in one direction and very stiff in the other.**

• • •

SOLDERING SPEED-UP

With Carbon Tip and Grounded Work

Replacing a completely manual operation that formerly took a considerable amount of time and required a great deal of soldering iron maintenance, an electrically heated carbon tip has been put into use in one of General Electric's industrial control factories. In the application illustrated in one of our photographs, the carbon-tip soldering method is applied to a plate-type

Assembly-line soldering

rheostat, although it could as readily be used for other purposes where the electrical circuit can be satisfactorily completed.

In the use shown, the assembled rheostat plate is placed in a grounded fixture. The operator then lowers the carbon tip into contact with the point to be soldered, heat is quickly developed, and the solder applied and sweated in.

PRODUCTION LIGHT

Increases Give Better Vision, Better Work

AMERICA'S war effort has boosted lighting levels in modern defense plants to four times their peacetime strength, according to S. G. Hibben, Westinghouse Director of Applied Lighting. "Widespread vision defects caused by poor industrial lighting in the first World War will not recur in the present conflict because American industry is now engaged in a virtual 'battle of footcandles' to outdo enemy nations in increasing factory illumination," Mr. Hibben declares.

Since the start of the defense program, modern plants have increased lighting levels from an average of 10 footcandles to 40 and 50 footcandles, the new standard for adequate installations. These levels are 13 or 14 times greater than the average of three footcandles used by industry from 1914 to 1918. Today, these old levels of illumination would be little better than the lighting found on a busy city street

NICKEL SAVING

In Electronic Equipment by Lining Up Crystals

ENOUGH nickel to make armor-plate for 55 medium tanks—20,000 pounds of it—will be conserved during 1942 by the Westinghouse Electric and Manufacturing Company through substitution of Hipersil steel—developed originally for electric transformers—for a nickel alloy in the manufacture of Ignitrons. These are electronic devices which convert alternating current electricity into the direct current required in the manufacture of aluminum and magnesium and for electric locomotives, steel mills, street cars, subway cars, printing plants, spot welding, and so on.

One part of the Ignitron equipment —a doughnut-shaped device known as a reactor—was formerly made of an alloy containing about 50 percent nickel. But when it became apparent that more and more nickel would be needed to make the steel alloy used in armor-plating tanks and battleships, the search started for a substitute material.

Seeking a magnetic material which did not contain scarce metals, reactors made of ordinary magnetic iron were first tried. This failed to work satisfactorily because the iron got hot and wasted too much power and failed to provide the magnetic qualities required by Ignitrons. When Hipersil steel was tried, the first reactor made with this metal not only performed as efficiently as nickel alloy reactors but turned out to be more satisfactory under changing temperature conditions.

Hipersil replaces nickel alloy

The magnetic properties of Hipersil steel are not materially affected by temperature changes, which range in the reactors from 70 to 200 degrees, Fahrenheit. A special silicon steel, it is produced by certain melting, heat treatment, and rolling techniques that rearrange its crystals and improve its magnetic properties—a process that enables a small amount of Hipersil steel to do the job of a larger amount of ordinary electrical steel. This method of steel treatment trains the metal's invisible crystals to "fall in line" and become better magnetic paths, with the result that Hipersil steel carries one third more magnetic flux or magnetism than ordinary steel For example, an electromagnet made of Hipersil steel will do the same amount of work as an ordinary silicon steel magnet one third larger.

FIBER CONTAINER

To Replace Cans, Made on Same Machinery

AFTER many months of experimentation, the American Can Company has developed a method for making "cans" with fiber bodies on machines used for the manufacture of metal containers. This new method, which will be made available to the entire industry as soon as it has been thoroughly tried and perfected through actual production, is considered the most important development within the can manufacturing industry during the past decade. The method brings the first ray of hope to the vast number of American manufacturers of dry products whose merchandise was packed in cans, and whose business is threatened with dislocation by restriction of metals.

The greatest merit, perhaps, of the new method, is that no new machinery is required. At a time when it is impossible to get new machinery or tools and materials with which to construct it, a method has been devised of feeding fiber sheets into existing machines geared for manufacturing metal cans and obtaining a reasonable facsimile of the old container. Another factor of merit is that the manufacturer of a product which uses the cans also may use his existing packaging machinery.

The new container will come to the rescue of those products known in the trade as "dry" such as drugs, cosmetics, spices, powders, and so on. A few liquid products may also be affected.

Under the new manufacturing method, paper will be run through the various tin can lines. The fiber, cut to sheets of tin plate size, lithographed on the regular presses formerly used for lithographing designs on tin plate, will then be sheared and formed into bodies. The black plate ends will be seamed on to the container with the regular seaming machine now in use.

SOAP FLAKES

Solve Industrial Production Problem

THE ladies who "Lux" their dainties daily may not find themselves up against priority problems quite yet because of war industry demands, but, in one instance, their soap flakes have been drafted for war production.

In broaching a hole in a pressure-pump valve part in mass production, difficulty was experienced in obtaining the desired smoothness of finish. Numerous cutting fluids were tried with indifferent success until the engineer from the Colonial Broach Company, makers of the broach, and the valve manufacturer, hit on the idea of experimenting with a solution of ordinary Lux and water. The result was completely satisfactory, the finished hole was as smooth as the ladies' dainties, and the Lux soap solution is now being used in regular production.

INDUSTRIAL TRENDS

LIFE LINES

If there is one thing this war has taught the public in general and the oil industry in particular it is that the most important factor in the whole problem of petroleum, from the drilling of the well to the use of the final product, is transportation. Too well known to warrant discussion here is the shortage of gasoline along the eastern seaboard and the threatened shortage of fuel oil for the coming winter. Everyone is familiar with the fact that these shortages are not due to any shortage of petroleum or petroleum products. It is a case of getting these materials to the ultimate consumer, the means for which are now limited by the exigencies of war.

As has been told in these pages and elsewhere, there are four main methods of transporting bulk shipments of the liquids which make up the stock-in-trade of the petroleum industry. These are the tank ship, the pipe line, the rail tank car, and the highway tank truck. Three of these have been hard hit indeed by the war. The oil tanker has found an implacable enemy in the submarine, the railroads are overburdened by the demands of shipments of other materials of war, and the tank trucks—smallest units in the transportation system—do not have the physical capacity to take over much of the burden and are getting short on the rubber tires so sorely needed for their continued operation.

This leaves the pipe line as the one method of getting liquids from here to there that is still functioning full-time in its original role. Unfortunately, however, this method is one that has, for one reason and another, not been developed sufficiently to carry the full brunt of the present situation. Ever since the first pipe line was built some 75 years ago, this method of transportation has been subjected to the indignation and bitter enmity of, in early days, the teamsters and, then as well as later, of the railroads and water-borne carriers. If it were not for this enmity there would undoubtedly be ample pipe-line capacity for all requirements and there would not now be any question about oil or gasoline shortages in some localities.

Be that as it may, even the tens of thousands of miles of pipe lines that are in active use today are still not sufficient to act alone as carriers of all the petroleum products demanded by the public, let alone the requirements of the armed forces. Thus it is that, because various elements opposed—and still oppose—the construction of pipe lines, this country finds itself with a surplus of petroleum products in some regions and a complete dearth in others.

When the economics of oil transportation are considered, it is a wonder that even the powerful opponents of the life lines of the petroleum industry were able to hold down the construction of pipe lines as much as they did. A pipe line is tucked away safely underground. It works 24 hours a day, seven days a week. Its operation is not hindered by ordinary storms and it is relatively cheap to build and operate. Many hundreds of miles of pipe lines can be built in the length of time required for constructing a tank ship and, averaged out over a long period of time, the pipe line will carry more oil per year than will the tanker.

Here's about how the figures work out. Although a tanker may carry up to 150,000 barrels per trip, the vicissitudes of the sea, and the distances involved, are such that a tanker with this capacity will average only some 4000 barrels per day, on a yearly basis. This is estimated on the average Atlantic Coast run. On the other hand, a 12-inch pipe line can handle some 60,000 barrels per day and can continue to do so with a regularity that spells fuel to consumers wherever the lines are available and as long as the pumps continue to operate.

Although tens of thousands of miles of pipe lines were mentioned a few lines back, it is necessary to understand what these lines are used for in order to appreciate the over-all picture of this phase of one of our most important industries. First, there are some 54,000 miles of gathering lines that carry the crude from the fields to the trunk lines. These latter, about 62,000 miles in total length, move the crude to refineries, storage tank "farms," and even to railway and ship terminals for further handling. About 10,000 miles of lines carrying refined products—gasoline, lubricating oil, and so on—complete the total of oil pipe lines. These products lines, by the way, are a comparatively recent innovation in the industry. Originally, pipe lines carried crude alone. Then, only a decade or so ago, gasoline was transported for the first time by pipe. Still later other products were pumped through pipes and, today, it is the products pipe line that is receiving the greatest attention. Such a line may carry, by correct manipulation of the control equipment, Diesel fuel, any one of many grades of gasoline, kerosene, lubricating oil, or other petroleum products. This flexibility is of distinct advantage to the operating companies and the products line is a development that has a promising future. Innovation that it is, there is every indication that the products line is so successful in operation that more and more of them will come into existence by conversion of crude lines. The probabilities are, also, that the end of the war will find this type of transportation so firmly intrenched in the petroleum industry that, as soon as materials are available once more, products lines will spread over the map of the United States like oil on water.

A hint as to the future possibilities of pipe lines in petroleum transportation of all kinds is to be found in the activities of securities analysts when they evaluate investments in the petroleum industry group. They pay careful attention to the pipe line holdings of the companies under consideration, thus pointing directly to the value of these lines now and in the future.

CARGO BY AIR

Something to get excited about, as seen from this vantage point, are the future possibilities of transportation of cargo by air. Dr. Klemin, our aviation editor, has treated this general subject in his monthly notes, and many far-seeing designers are working steadily on the special problems involved.

One thing to keep in mind when considering this specific trend in the aviation industry is that, according to informed engineers, it will not be practical, when peace comes, to convert military planes to cargo operation. Planes for fighting purposes, whether they be pursuits, bombers, or whatnot, are designed for high performance with little or no thought of economy of operation. For the cargo plane of the future, performance will become entirely secondary, and main emphasis will be placed on economy. So long as the plane has high speed and safety and can fly long distances with fuel economy, it will have at least an even chance of competing with other forms of transportation. Thus, completely new designs are and will be forthcoming.

—The Editors

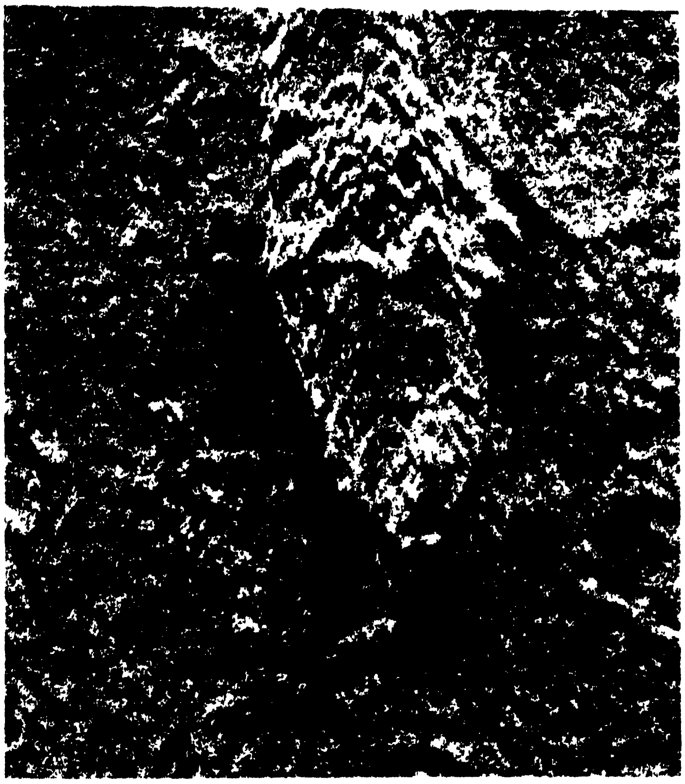
The Scanning Electron Microscope

High Magnifications of Opaque Objects With New Instrument Combining Developments in Many Fields

Dr. VLADIMIR K. ZWORYKIN
Associate Director, RCA Laboratories

Images of objects may be formed in two basically different manners Either the picture as a whole may be projected simultaneously on the recording surface, as typified by the photographic camera, or it may be formed by the sequential recording of its elements, as a painting takes shape under the successive brush strokes of the artist. Practically all optical instruments, including the standard RCA electron microscope, utilize the first method for image reproduction. Television and electric picture transmission or facsimile, on the other hand, analyze the picture to be transmitted into a large number of minute picture elements, successive signals derived from adjacent elements, and proportional to their brightness, serving to control the intensity distribution in the re-synthesized image on the viewing tube screen or recorder paper The scanning electron microscope belongs to the same class of image forming devices.

The special sphere of usefulness of the scanning electron microscope lies in the observation of surfaces of opaque objects, just as the standard electron microscope is primarily adapted for the viewing of transparent specimens. The boundary between transparency and opacity for electrons of the order of velocity normally employed in electron microscopes lies in the neighborhood of 1/100,000 of an inch. The standard electron microscope cannot be adapted to the direct observation of surfaces without a great loss in resolving power. It is thus the aim of the scanning electron microscope to extend the range of observation in metallographic microscopy as the standard electron microscope has already extended it in the bacteriological, chemical, and related fields.

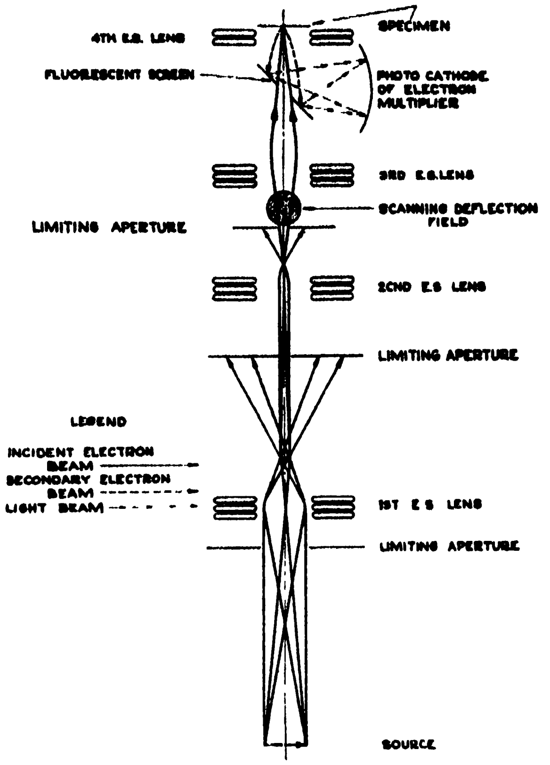


Etched brass, as pictured by new microscope

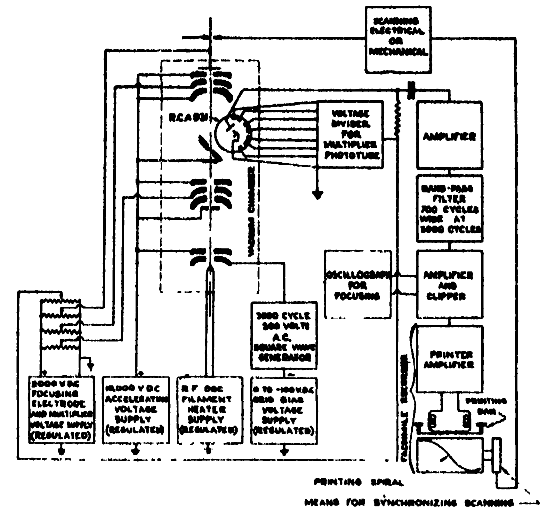
Various researches concerned with the application of the methods of electronic television to problems of microscopy have been carried on in the RCA Laboratories over a period of over eight years Thus, at an early stage a directly coupled television pick-up and receiver unit was combined with an ultra-violet microscope so as to yield a visible image of readily controlled brightness and magnification. Here the television equipment served primarily to convert an invisible into a visible image and did not participate in the formation of the original magnified image. In order to obtain a genuine scanning microscope it was necessary to replace the ultra-violet-sensitive mosaic in the pick-up tube by the object itself. If, with the latter arrangement, the scanning amplitude in the pick-up tube—that is, the scanning area on the object—is reduced, leaving the scanning in the viewing tube unaltered, an enlarged image of the object is formed on the fluorescent screen, the variation of brightness in the latter corresponding to the variation in the secondary emission sensitivity of the specimen. The magnification of the image is simply equal to the ratio of the scanning amplitudes on the object and on the screen of the viewing tube.

Simple as the basic principle of the scanning electron microscope may thus appear, the realization of an instrument with a resolving power comparable with that of the standard electron microscope meets very great difficulties. These arise primarily from the necessity of making the scanning spot no larger than the least separation which is to be resolved—that is, no larger than approximately one two-millionth of an inch (or 100 angstrom units) in diameter. A spot of this size may be realized by forming a reduced image of the "crossover" in front of a hot cathode by two short-focus electron lenses operating in two reducing stages; in short, the source is placed at the center of the image plane of a high-power compound electron microscope, the spot being formed where, normally, the object is located. As the electron lenses of this "microscope" are afflicted with spherical aberration in the same manner as other electron lenses, the requirement of a fine spot demands not only a high reduction ratio, but also a restriction to very narrow imaging beams. It may be shown that under these circumstances the current in the spot of the required size has a fundamental upper limit of the order of one millionth of a microampere The variations in the secondary emission of the specimen which are responsible for the image detail may normally be expected to have an amplitude of the order of 1/10 of this amount

If it should be attempted to amplify this signal current of 10^{-13} amperes or less with a regular television amplifier, and to apply the amplified current to the control grid of a television receiving tube, no picture whatever would be obtained—the picture detail would be completely lost in picture "noise" since, with the speed of scan-



Left: **"Ray" diagram of the scanning electron microscope, showing beams and lenses**


SCANNING ELECTRICAL OR MECHANICAL
RCA 931
VOLTAGE DIVIDER FOR MULTIPLIER PHOTOTUBE
AMPLIFIER
BAND-PASS FILTER 700 CYCLES WIDE AT 3000 CYCLES
VACUUM CHAMBER
OSCILLOGRAPH FOR FOCUSING
AMPLIFIER AND CLIPPER
3000 CYCLE 300 VOLTS A.C. SQUARE WAVE GENERATOR
PRINTER AMPLIFIER
2000 V DC FOCUSING ELECTRODE AND MULTIPLIER VOLTAGE SUPPLY (REGULATED)
10,000 V DC ACCELERATING VOLTAGE SUPPLY (REGULATED)
R F OSC FILAMENT HEATER SUPPLY (REGULATED)
0 TO -100 V DC GRID BIAS VOLTAGE SUPPLY (REGULATED)
FACSIMILE RECORDER
PRINTING BAR
PRINTING SPIRAL
MEANS FOR SYNCHRONIZING SCANNING

Right: **Schematic arrangement of the various parts of the scanning electron microscope**

ning required, only about one secondary electron is given off on the average by each picture element, making it quite impossible to transmit information regarding a fractional variation of the secondary emission sensitivities of the picture elements.

Accordingly, although scanning microscopes of relatively low resolution (down to 1/20,000 of an inch or one micron) were successfully constructed even with the image observed directly on the fluorescent screen of a kinescope, high-resolution instruments required a slower method of recording. A facsimile receiver, registering an image in eight minutes (as compared with 1/30 of a second for a television receiver), proved to be a satisfactory solution. By this means the number of electrons emitted per picture element was increased by a factor of about 6000, the total number of picture elements in the image being, simultaneously, doubled.

Even so, a satisfactory image could only be obtained by the employment of a practically noise-free amplifier—the electronic secondary emission multiplier tube. The secondary electrons, in place of being collected directly, are permitted, after suitable acceleration, to fall on a fluorescent screen, whose light emission is concentrated on the photo-cathode of the multiplier. By matching the spectral sensitivity variation of the photo-cathode to the emission bands of the fluorescent material it is possible to attain a photocurrent in the multiplier which exceeds by a considerable factor the electron current incident on the fluorescent screen.

The general arrangement of the scanning electron microscope is shown schematically in one of the drawings, certain modifications of this arrangement, incidental to a replacement of mechanical scanning by magnetic scanning in the final instrument, are evident on the "ray" diagram.

Referring to the general arrangement drawing, the electron source, at the bottom of the microscope, consists of a thin tungsten wire fed by a regulated radio-frequency power supply. It may be oriented with respect to a two-element electrostatic lens comprising the grid and the anode of the electron gun by means of three micrometer screws A 3000-cycle square voltage wave is applied to the grid so as to give the beam, and hence the signal current, a 3000-cycle modulation. In addition to this, a variable D C. grid bias is provided to regulate the current in the beam.

The anode, as well as the remainder of the channel through which the beam passes, with the exception of the center electrodes of the two reducing lenses and the specimen itself, is normally maintained at a potential of 10,000 volts with respect to the cathode, the voltage supply being stabilized by negative feedback to within 001 percent.

After traversing two masking apertures, the beam passes through the first electrostatic reducing lens, which forms an image of the crossover of the beam, the reduction factor being of the order of 50 It may be adjusted by varying the potential of the center electrode with respect to the cathode, a stabilized 2000-volt supply being provided for this purpose About halfway between the first and second lens, at the end of a narrow tube acting as

Shown here with the recently perfected scanning electron microscope are Dr. James Hillier (foreground), Richard L. Snyder, and Dr. Zworykin, the author, at the right

an electrostatic shield for the beam, is another aperture of the final lens, placed approximately at the center of an inclined fluorescent screen The final lens, similar in construction to the first lens, forms the scanning spot, imaged on the specimen. The latter may be translated in three directions in the same manner as the source.

On striking the specimen, the primary electrons eject secondary electrons from it. These have low initial velocities, corresponding to accelerating voltages between 0 and 10 volts The strong accelerating field between the specimen and the uppermost electrode of the final lens draws them back through the final lens, which focuses them at some point between it and the inclined fluorescent screen Due to the smaller initial velocity of the secondary electrons, the lens action of this lens is much stronger for the secondary electrons than for the electrons of the original beam. The secondary electrons, diverging from their point of focus, form too wide a beam to pass through the fine aperture in the fluorescent screen. They fall on the screen instead and their energy is, to a considerable extent, converted into the bluish light characteristic of the luminescent substance employed A large fraction of this light falls on the photo-cathode of the electron multiplier placed in a favorable position relative to the screen and gives rise to a photo-current which, suitably amplified and filtered, forms the signal current controlling the printer bar of the facsimile recorder.

In the earlier instruments the scanning was accomplished by the mechanical displacement of the specimen, the motion of the latter being linked electrically or hydraulically with the displacement of the recorder drums with the aid of suitable cams mounted on the axes of the drums. Since adequate precision in the scanning could not be obtained by this means, magnetic scanning was provided in the final instrument. The deflecting yoke is placed directly below an auxiliary lens of approximately unity magnification, the primary purpose of the latter being to provide space both for the deflecting yoke and the fluorescent screen. After passing through a hole in the screen the primary beam traverses a decelerating lens and strikes the object. The returning secondaries spread out over an area about the hole, causing the screen to fluoresce in proportion to the intensity of the secondary emission current. The light from the screen, finally, is concentrated by a wide-aperture lens on the photo-cathode of the multiplier. The area of the specimen which is scanned is normally only about 1/1000 of an inch in diameter.

A picture of an etched brass surface obtained with the scanning electron microscope is reproduced in these columns. The resolution is here of the order of 500 angstrom units, representing a great improvement over the optimum obtainable with the light-optical metallographic microscope. As with any new device, it is not possible to judge the full range of utility of the scanning microscope at the present time It is an interesting fact, however, that its perfection has been made possible only by a large number of concurrent developments encompassing the fields of television, facsimile, secondary emission multipliers, fluorescent materials, and electron microscopy

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METAL DETAILS

Reproduced in Film for Electron Microscopy

PLASTIC films one five hundred thousandth of an inch in thickness, equal to about a tenth of the length of yellow-orange light waves, have been found best by General Electric scientists for revealing details of metal surfaces under the electron microscope. A full account of the technique by which these films are made and used is published in the *Journal of Applied Physics*, in an article by Vincent J Schaefer and Dr. David Harker.

After the metal sample is polished and etched for a few seconds with acid, it is dipped into a dish containing a solution of Formvar, a plastic, in dioxane, a commercial solvent. The authors point out that it is necessary to do this within a few minutes after the sample has been etched and dried Otherwise an infinitesimally thin film of grease or other contaminating material may start to form.

After dipping in the Formvar solution, the solvent evaporates, leaving the plastic film, which is then stripped off, and on which are reproduced the microscopic hills and valleys of the metallic crystals. The film can then be placed in the electron microscope for examination.

Mr. Schaefer and Dr. Harker find that the exact thickness of the Formvar film is important, and this can be regulated by the strength of its solution in dioxane Very thin films, about a millionth of an inch, do not show much contrast in the final electron picture. This seems to be because the film both on top and bottom follows the hills and valleys of the metal. Thus it is all nearly equally transparent to the electron beam. If the film is as thick as 1/250,000 of an inch, contrast is also poor.

Best thickness is around 1/500,000 of an inch. Such films are just thick enough to make the top of the film level, while the bottom reproduces the hills and valleys.

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HEAT—A temperature of 45,000 degrees, Fahrenheit, has been momentarily produced at the National Bureau of Standards by discharging, through a quartz tube with a one-tenth inch bore, 40,000 kilowatts of electrical energy over a period of five millionths of a second.

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WOMEN IN SCIENCE

Interest In Tackling Problems Is Essential

THERE are plenty of opportunities for women in science, and an interest in tackling problems is essential for those who want to take up such work, according to Dr. Katharine Blodgett, physicist of the General Electric Research Laboratory.

"The requirements for work in a laboratory are not so different from the requirements for successful work in any vocation," she said. "For laboratory work you need formal training, of course, and, in addition, you need persistence, patience, and a knack at solving problems--and the most important of these is the knack at solving problems

"Often college students come to my laboratory to ask if I think they would make good laboratory workers. They are complete strangers to me--I do not know if they would make good laboratory workers. And so I ask a student this question· Is she interested in tackling problems—not just laboratory problems, but everyday problems outside of the laboratory—all those commonplace, unexpected, and sometimes unenviable problems that come up that somebody has to solve? For example, if the plants in the garden at home are being eaten at the root by cutworms; or if she has caught her dress on a nail and doesn't know how to mend the tear; or if her favorite summer camping spot is becoming carpeted with poison ivy—does she tackle the problem?

"There are people," Dr. Blodgett continued, "who are never interested in solving problems. I think that one reason is because they never outgrow the childhood complaint of saying, 'I can't,' which is just another way of saying, 'I won't try.'"

The Nebular Spectrum

More Impressive Grows the Evidence for the Uniformity of Composition of Matter in Space

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

ONE of the ablest of the younger group of American astronomers, Dr. Arthur B. Wyse, lost his life in the service of his country on June 9th in the collision of two naval airships. The nature of the technical problem upon which he and several colleagues in other sciences, who were also lost, were engaged has not been revealed. But the record of his astronomical work, in the brief span of nine years, provides a worthy and permanent memorial

Twice within the last few months we have had occasion to describe, in these columns, work in which he had a share. He was the first to discover the remarkable bright lines in the spectrum of RW Tauri, which later revealed the existence of the ring of gas rotating around it, of which we told in July, and his skill in intricate mathematical analysis had a large part in the successful interpretation of the rotation of the Andromeda nebula, and its neighbor spiral, Messier 33, which we described in June

His principal contributions to science, however, were in the study of spectra Three years ago, he and Dr Bowen—the discoverer of the nature of the "forbidden" nebular lines—published an admirable study of the spectra of three bright planetary (gaseous) nebulae, finding for the first time evidence that atoms of metals as well as of permanent gases were present in them A continuation of this work, extending the observation of ten nebulae, was fortunately completed by Dr. Wyse just before he left the Lick Observatory for war service, and was published but a few days before his death. Quite apart from this tragic interest, it well deserves our consideration this month for its inherent scientific quality

Nine of the nebulae included in this study are "planetaries." Few, if any, more inappropriate adjectives have survived from old times to confuse modern astronomical language. These nebulae show visible disks, sometimes of considerable size, and thus far have a slight resemblance to planets; but the resemblance goes no further, for they are usually oval, and often considerably irregular, in shape. Practically all such nebulae possess a central nucleus, appearing like a faint star, much brighter on photographs than when observed visually. There is conclusive evidence that they are actually shells of gas, enormous in size and of excessively low density, which surround the nucleus, and are set shining by the effects of very short-wave ultraviolet light emitted from the nucleus The nuclei themselves appear to be exceedingly hot stars—the hottest so far known. The tenth of Wyse's nebulae was an object of very different type—the Great Nebula in Orion—a huge chaotic mass of luminous gas, of very irregular form, which is set shining by radiation from a group of bright hot stars near the middle.

THE main purpose of the investigation was to observe as many as possible of the faint emission lines which are known to exist in these spectra, and all known light-saving devices were applied. For example, the image-slicer, which concentrates the light from different parts of the nebula into narrow strips of spectrum, side by side, was used on all the planetaries. (The Orion nebula is so big that this was not necessary.) In an ordinary spectrograph, much light is lost by reflection at the many successive surfaces of the lenses and prisms through which it must pass. By coating these surfaces with exceedingly thin transparent films of fluoride of lithium or of magnesium —evaporated upon them in a high vacuum—the reflection loss was so much reduced that the photographic speed was more than doubled. An additional gain was made by increasing the sensitivity of the plates by exposing them to mercury vapor shortly before use.

All these devices together did not escape the astronomer's usual requirement of long exposures—they made these give better results. For almost all the nebulae two exposures of from 14 to 19 hours' duration, on two or three successive clear nights, were made—one for the red, the other for the violet end of the spectrum. The brightest lines could be recorded in a few minutes. A limit to the search for faint lines is set by the fact that most of the nebulae show a faint continuous background of emission spectrum. In some, this comes from the nucleus, but in others—notably in the Orion nebula—from the nebulosity itself.

To show faint lines against this background can best be achieved by using a spectrograph of quite different proportions from those employed in the study of faint extra-galactic nebulae. The latter have a camera of very short focus, so that the spectrum on the plate is but a small fraction of an inch in length. The resulting concentration of light is just what is needed to bring out a faint continuous spectrum crossed by dark lines. But in the nebulae the lines are bright, on a less luminous background. Here it pays to use a rather high dispersion This draws out the continuous spectrum, and makes it fainter, while the images of the narrow bright lines are set farther apart, but are no wider, and so they are easier to see.

THESE pains were well rewarded Wyse's final list contains 351 bright lines, observed in one or more of his ten nebulae between 3704A in the near ultra-violet and 6755 in the red Some of these were observed only in a single object, at the very limit of visibility. Omitting these (which were included to make a complete record) the list contains about 270 bright lines which are undoubtedly present in the spectra of gaseous nebulae, or of their nuclei This is three times as many as were known when the investigation was begun by Bowen and Wyse in 1938. The great lenses of the Lick 36-inch refractor, with which the observations were made, are practically opaque to ultra-violet light below 3700. With reflecting telescopes, aluminized mirrors, and quartz prisms, many additional lines have already been found in the ultra-violet, and the extension of the thorough survey would probably raise the number of known nebular lines well toward 350. Observations with plates sensitive to the deep red and infra-red, both by Wyse and by others, have revealed very little.

On the whole, the spectra of the ten nebulae are remarkably similar.

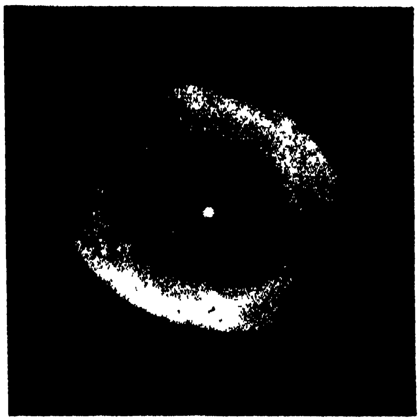
Some of them show a greater degree of excitation than others, and lines emitted by highly ionized atoms are confined to these. This may be connected with very high temperature of the central star. The Orion nebula indicates a rather low excitation.

Two close pairs of lines—of neutral nitrogen at $\lambda 5199$, and of singly ionized oxygen at $\lambda 3727$—are known, from calculations based on atomic theory, to be much more strongly forbidden than the rest; that is, an atom would have to be let alone much longer before it "got around" to performing the transition which produces these lines. There are one or two nebulae in which these strongly forbidden lines are brighter, in comparison with the others, than in the rest. It is very probable that these nebulae are of exceptionally low density, so that the atoms in them are less frequently disturbed by collisions with other atoms, and have a better chance of emitting the strongly forbidden lines.

When allowance is made for these factors, there remain remarkably few outstanding differences between the ten nebulae, and Wyse concludes that "the variation in line intensities, among the nebulae observed, arises primarily from differences in physical conditions rather than from differences in chemical composition."

COMBINING his results with those of earlier observations, he gives the following long list of ions represented in the spectra of one or more of the nebulae observed: *H* I, *He* I, *He* II, *C* II, *C* III, *C* IV, *N* I, *N* II, *N* III, *N* IV, *N* V?, *O* I, *O* II, *O* III, *F* II?, *F* IV, *Ne* III, *Ne* V, *Mg* I?, *Si* II *Si* III?, *S* II, *S* III, *Cl* III, *Cl* IV, *A* III, *A* IV, *A* V, *K* IV, *K* V?, *K* VI, *Ca* V, *Fe* II, *Fe* III, *Fe* VI, *Fe* VII, *Ni* VIII?. This is an impressive list in many ways. Sixteen elements have now been identified (two doubtfully) in the nebulae, including several metals, and silicon (which behaves spectroscopically like a metal). These metals show strong lines and must be abundant in ordinary stellar atmospheres. There are, however, two elements—fluorine and chlorine, which have been found spectroscopically in the nebulae, and not, so far, in the stars (except for fluorine compounds in the Sun). This is easily explained. Elements with strong forbidden lines have an enormous spectroscopic advantage in nebulae, and fluorine and chlorine are definitely of this sort. In stellar spectra, however, the spectroscopic conditions are against them. Their strong lines are inaccessible in the far ultra-violet and the only available ones would show only in hot stars.

Similar allowances for favorable and unfavorable spectroscopic conditions have to be made in the case of many other elements. When this is done, Wyse confirms, from much more extensive data, the conclusion that he and Bowen reached in 1939—namely, that the relative intensities of the spectral lines in the nebulae are very much what would be expected if their actual composition was similar to that of the atmospheres of the Sun and the stars. For a detailed discussion of individual cases, the interested reader may be referred to the original paper (*Astrophysical Journal*, May, 1942). About 40 percent of the observed nebular lines remain unidentified. Most of them are very faint, and the unidentified lines, taken together, contribute less than 5 percent of the total energy of the nebular radiation; but there is a good deal of work still to be done in finding their origin.



Courtesy Mt Wilson Observatory

What is a planetary nebula, in relation to the total of astronomic objects? The great units of the universe are galaxies of stars of which the spirals are the most familiar. Our galaxy, the Milky Way, is one of these. Like the rest, its most familiar units are suns—billions of them. In addition, there are some oddities, relatively very small in number: diffuse nebulae (formless clouds of gas, glowing or dark) and the egregiously misnamed "planetary" nebulae (formed clouds of gas surrounding central stars). The "Ring" Nebula in Lyra, above, is one of these but it is not a ring. A sphere surrounding a central star which caused it to glow might photograph as a ring, there is more substance in the "ring" portions to send out light, a matter of geometry. As Professor Russell pointed out in December, 1937, planetary nebulae are utterly unlike planets in every way

It requires no great technical training to recognize that the metals definitely found in nebulae—silicon, potassium, calcium, and iron—are among those which are most abundant, not only among the stars, but in the composition of terrestrial rocks. It is well known, too, that the permanent gases are more abundant in the stars than are even these metals—hydrogen and helium being far ahead of the rest—and this again fits perfectly with the nebular spectra.

A few years ago, the statement that the Orion nebula was partly composed of iron would have appeared to be incredible, if not absurd. Now, 10 forbidden lines of *Fe* II, and about 15 of *Fe* III, have been definitely observed by Wyse, so that there can be no doubt about it. In the meantime, all surprise has been removed by the even more remarkable discovery that atoms of iron, very thinly distributed, form part of the gas which is distributed throughout inter-stellar space. Calcium and potassium, too, are known to be present in the inter-stellar gas.

Year by year, the evidence for the general uniformity of composition of matter, throughout the regions of space accessible to our observation, becomes more and more impressive. The Orion nebula, according to Wyse, appears to be very similar in composition to the planetaries. Yet, as he remarked, "While little is known of the origin of planetary nebulae, it seems likely that they consist of matter that has been thrown off from the central stars. The diffuse nebulae, on the other hand, as typified by the Great Nebula in Orion, have presumably never been in the form of stars."

At first glance this appears surprising, in view of the evidence that atomic transmutation occurs inside the stars and provides them with their energy. But it may be remarked that of the elements characteristic in nebular spectra, hydrogen is the as yet unexhausted fuel of the atomic process; helium the slowly accumulating ashes, carbon and nitrogen the self-renewing catalysts by whose aid the process is carried on, while oxygen, and all the heavier elements, are unaffected at the temperatures and densities which so far as we can judge prevail inside the stars.

THE light elements—lithium, beryllium, and boron—would give us diagnostic evidence. But, unfortunately, the structure of their spectra makes it certain that they can have no forbidden lines. It also is very unfavorable to detecting them at all spectroscopically (except for neutral lithium) in the heavenly bodies. The similarity of the Orion nebula and the planetaries is therefore not so remarkable after all.

One cannot close this sketch of a very beautiful piece of research without the expression of profound regret that so able an investigator has been lost alike to the service of science and of the nation.—*Princeton University Observatory, July 3, 1942*

Pumps For Home Protection

Simple Units for Use in Combatting Incendiary Bombs and Fires Can be Made from Available Material

GEORGE H. STAHLER

A CONSTRUCTION "project" that will interest many home owners as well as civilian defense units, Boy Scout troops, and so on may be built up around home-made pumps for protection against fire and incendiary bombs.

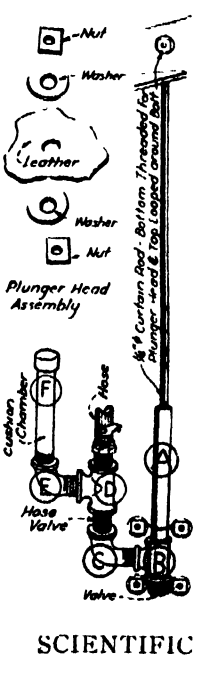
The author has found that galvanized pipe and fittings are perfectly satisfactory for these pumps; even scrap material, if cleaned thoroughly, will serve. The drawing at the bottom of the page shows the essential parts of the pumps, the letters on the sketch corresponding to these in the specifications which follow:

Pump No. 1. A—1" by 8" pipe B—1" by ½" by ½" tee C—½" st. elbow. D—½" by ⅜" by ½" tee. E—½" by 1" st. elbow. F—1" by 9" pipe. Height of pump overall 34". Stirrup arrangement is separated from main board a distance of 2" and the upward opening for insertion of pump in pail is 15". The main board is 4" wide. Nozzle opening—5/64". Maximum stroke—6".

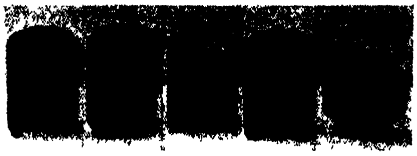
Pump No. 2. A—¾" by 8½" pipe. B—½" thread tapped inside bottom end of A. C—¼" pipe nipple which screws into tapped hole in A just above intake valve, plus a ½" pipe cap which has been drilled and tapped for the other end of nipple. D and E; a ¼" tapped hole has been made in F just above the valve. Into this hole a short ¼" nipple has been placed, to which a piece of ⅜" pipe is attached to provide a hose connection. F—¾" by 9½" pipe threaded internally at one end to provide threads into which the valve can fit. Height overall—34". Nozzle opening—5/64". Maximum stroke—6".

As the photographs of the valves show, a ½" galvanized pipe nipple is the basis on which they are made. To this has been added a valve seat and stopper which should be of non-corrosive metal. The top of an electric light socket may be used for the valve seat, and a brass flat-head screw or bolt for the stopper, as shown in the center valve photograph. A modification of this type, also shown, uses a brass ball, while still another employs a copper rivet. The unit at the right is a ½" pipe end used by electricians. Into it is pressed a piece of brass screen. This is used as an intake valve strainer.

Below: At left, side and front views of pump No. 1. At right, pump No. 2. **Drawing:** Essential parts of both pumps, with letter references to the text. **Above:** Four types of home-made nozzles.



Nozzles for these pumps are show in the center photograph on this page. These illustrations are practically self-explanatory, the dotted lines showing holes drilled to produce a spray or stream as desired. In the first nozzle control is by shutting off either one hole or the other with the thumb. The body of the second valve illustrated is made from a piece of oil-soaked wooden dowel with a metal lever control. Control of the third valve is accomplished by squeezing the rubber tube, and of the fourth valve by changing the cap from one jet to the other.



Four valves and strainer

Both of these pumps are designed to be used with 12 feet of ⅝" garden hose.

[More complete data on these and other types of pumps are available from the author. Address him in care of this magazine.—*The Editor.*]

BOMB SNATCHER

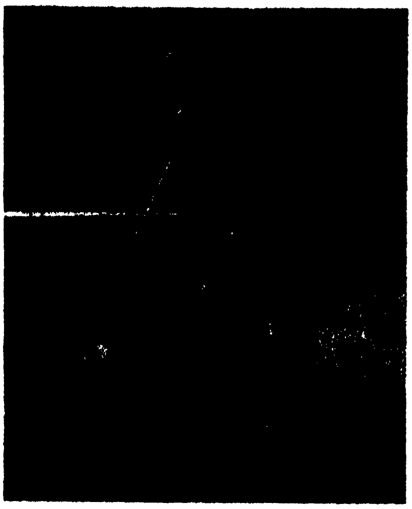
An Effective Tool for Handling Incendiary Bombs

To get rid of incendiary bombs before they have a chance to do damage is the object of the "Bomb Snatcher," made by the McGraw Electric Company, shown above. A lever controls the two semi-cylindrical refractory-lined jaws.

SIMPLE PUMP

No Strategic Materials Enter Its Construction

A COMMERCIAL pump for home protection against incendiary bombs and fires, designed to replace the conventional stirrup pump which requires priority materials, has been developed by The Zadig Patents. This unusual new pump, shown at the right, is made entirely of wood and fabric, even the two lengths of hose containing no rubber. The operator stands on the base of the pump when using it and works the handle back and forth. The handle can be detached and the pump folded flat for storage when not in use.



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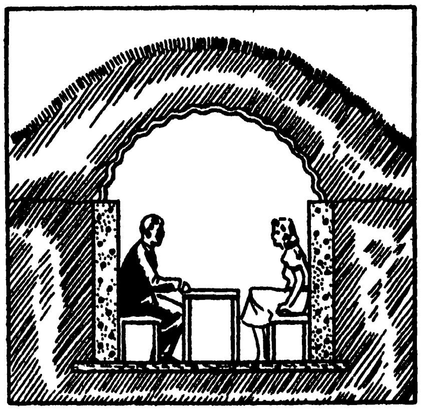
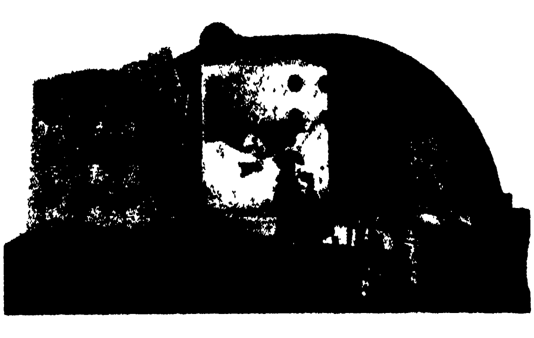
Air-Raid Shelters

Primary Consideration Should be Given to the Possibilities of Private Types of Shelters

A. D. RATHBONE, IV

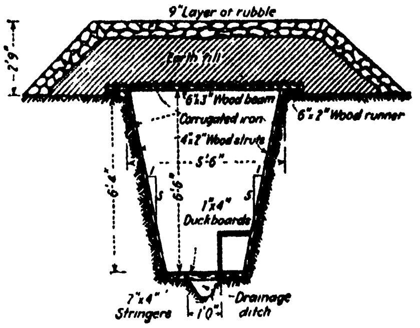
WHEN and if the bombs come to American cities, there will not be enough air-raid shelters for everyone who thinks he should be in one. We have no time, labor, or materials to spare from war production for the construction of public shelters in sufficient number and variety to offer even the minimum of safety for all civilians on coastal cities, not to mention inland manufacturing centers. Furthermore, and contrary to popular American belief, we don't need *public* shelters. After 12 months of the most intensive bombings, England found the risk of death from the air was only about six times that of death from automobile accidents. Current writers on civilian defense report that British experience with public sleeping shelters has produced more negative arguments than positive for the well-being of the public—they are dangerous to public morale, liable to cause development of psychoses, and tend toward heavy concentrations of civilians, rather than toward the safer policy of dispersion. A census, taken in January, 1941, showed but 5 percent of London's population using public shelters, only 19 percent utilizing communal or domestic types. The rest slept in their own beds.



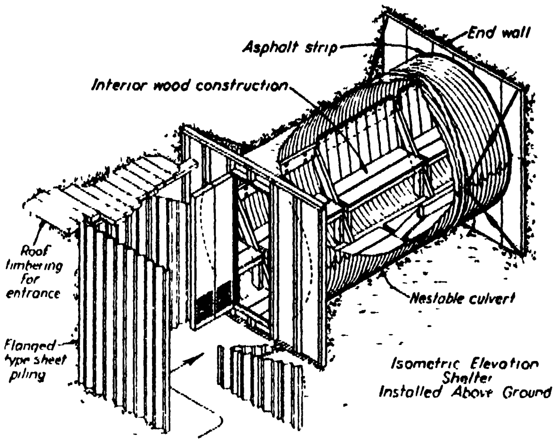


Above: Anderson type of domestic shelter. Inexpensive and effective against blast and splinters. Poor on heat, sanitation. Reproduced by permission from "What the Citizen Should Know About Civilian Defense," by Messrs. Binger and Railey, published by W. W. Norton & Co. **Right:** Solid Timber Shelter, for indoor use, has room for standard double bed mattress, with space for equipment at both ends. It is constructed of non-priority materials throughout

Inasmuch as Mr. Average Citizen is not going to find a specially constructed shelter at every street corner, what precautionary measures should he take? First, arrange for protection at home, for that's where Mr. Average Citizen spends most of his time each week, that's where his family is most likely to be, and, if he or any member of his family should be away from home when bombs come, there are just two simple rules: (1) Avoid panic; (2) Obey instructions from police, firemen, air raid wardens, or other qualified protective forces.



A covered trench shelter, from "Civil Air Defense," by Prentiss, by permission of Whittlesey House


Asphalt strip
End wall
Interior wood construction
Roof timbering for entrance
Flanged type sheet piling
Nestable culvert
Isometric Elevation Shelter Installed Above Ground

Armco 72-inch diameter nestable pipe air-raid shelter, reproduced from "Aerial Bombardment Protection," by H. E. Wessmann and W. A. Rose, published by John Wiley and Sons

In his book, "Civil Air Defense," Col. A. M. Prentiss states: "The importance of home protection is appa-

(*Please turn to page 141*)

Buckets of Blood . . .

Your Blood Donation, an Absolutely Painless Procedure, May Help Save a Warrior's Life

HOWARD C. FORST

IMAGINE a train of 18 railway tank cars filled to capacity, not with gasoline or other conventional cargo, but with human blood. This, were it to retain its original bulk, approximates the space which would be required to transport the blood reserve now being gathered for use by the United States Army and Navy medical staffs 1,215,000 units is the figure which expresses the actual quantity—a unit being about one pint, the average amount taken from a donor in the course of a single transfusion

Volunteers stream steadily through Red Cross headquarters in all cities where blood donations are accepted, New York alone accounting for more than 400 daily. The entire procedure—harmless, painless, and devoid of virtually all discomfort or unpleasant after-effects—requires only about half an hour; the transfusion itself, not more than ten minutes. Upon its completion, the donor returns immediately to normal activities, unmarked by his experience save for a small pat of adhesive tape on the inner side of his elbow joint, and the memory of a merciful contribution which may well save an otherwise lost human life.

Down through the centuries, physicians have fumbled with the idea of curing the sick with potions or injections of blood from the healthy Though such efforts resulted often in serious after-effects or even death for donor and recipient alike, there were occasional outstanding successes—rare to be sure, but frequent enough to taunt the curiosity of the scientist, and to keep alive his interest in transfusion Then, in 1900, Karl Landsteiner, a young Viennese bacteriologist, began a series of experiments, mixing blood serum and red corpuscles from different individuals—serum being the liquid which remains after clotting. Shattering accepted theory of that day, which held that all human blood is identical in structure, these experiments led to the ultimate emergence of the now well-known four blood groups or types, each of which is quite distinct from the others The red corpuscles of each group contain substances which react unfavorably when serum from another group is introduced into the circulatory system. Thus, the disastrous outcome of most previous transfusion attempts had been due in large measure to this random intermixture of opposing blood substances.

In the light of this surprising discovery it seems strange that, for the better part of two decades, little attention was given the therepeutic value of properly grouping blood donors and recipients. During the first World War, however, the procedure was adopted by the A.E.F and proved highly beneficial General acceptance followed quickly and before long the treatment was applied for a wide variety of conditions, running the alphabetical gamut from "bleeding in haemophelia" to "wasting anemia"

All photos New York Chapter, American Red Cross

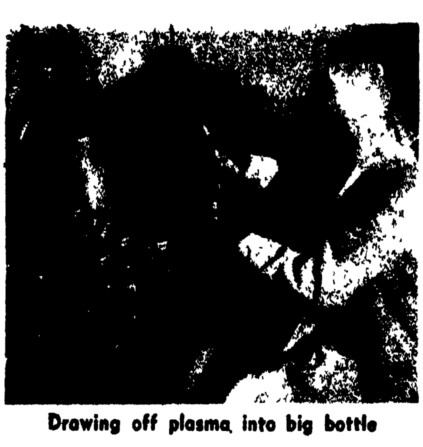
Taking donor's blood Painless

Until less than five years ago, the chief difficulty in the way of transfusion therepy lay not in failure of physicians to appreciate its merit, but rather in the very conditions which so often created most imperative need for its application. Frequently, where blood was urgently required—as in major disasters—a ready supply of suitable donors was not available.

Gratifying results had been obtained in a few cases by transfusing only plasma—a blood liquid differing in but minor chemical degree from serum. Unlike whole blood, which was known to be unfit for use after a week's storage, plasma could be preserved from six months to a year, and had the additional advantage of being safe for transfusion without the necessity of typing. Serious laboratory experiments were forthwith begun, and soon, again, the ill wind of war intervened to blow humanitarian good. The 1940 London bombings, with their consequent heavy civilian casualties, pressed home the need for readily available and easily transfusable quantities of blood. To such demands plasma seemed the logical answer. Since, under stress of war, England could not complete the essential donor organization with sufficient rapidity, it was agreed that plasma should be furnished by the United States. The New York Chapter of the American Red Cross took over recruiting of donors, while the Blood Transfusion Association supervised technical procedure.

THIS campaign lasted five months—over 15,000 persons giving approximately a pint of blood each. Such, indeed, are the unpredictable twists of circumstance! Almost before the program was well under way those serious laboratory experiments, so cautiously begun, had grown, because of great and sudden need, into a full scale, mass-production activity, serving an international cause.

Blood was taken from donors by means of a hollow needle inserted into a vein in the arm It flowed directly into a sterile glass container and there the red and white corpuscles (which are not used in plasma transfusion) settled in a thin layer. Later, the liquid plasma was drawn off Where a centrifuge was available, the settling process could be greatly accelerated: for, by whirling the jar on this wheel-like apparatus, the corpuscles, instead of requiring several days, were precipi-

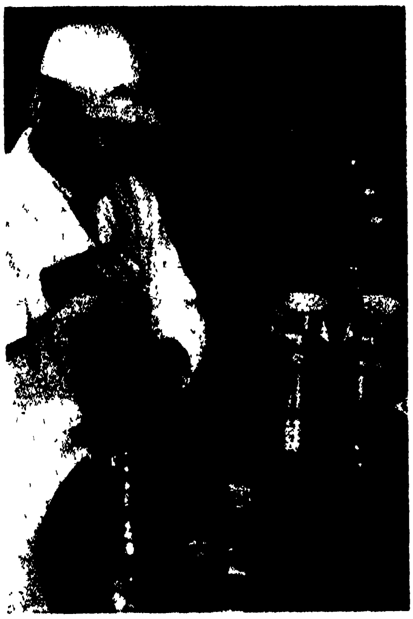


Drawing off plasma into big bottle

tated in about half an hour, after which the plasma could immediately be removed. As soon as laboratory tests had approved individual specimens of each blood, the plasma of several donors was pooled into a kind of sanguineous cocktail which was then subjected to further tests, before final shipment abroad.

While the campaign for Britain was still in progress a new project was organized to experiment with the drying of plasma. It was reasoned that a dry product could be compressed into far smaller space than that required for liquid (an important factor in shipping), while at the same time it would be in less danger of contamination. Technique was developed rapidly and, as has now been positively established, dry plasma has the further advantage of being safe for use after as long as five years storage, with indications that it can probably be preserved indefinitely.

Soon the Army and Navy stepped in with consecutive requests for the huge quantities of "powdered plasma" now in process of being gathered From the donor's viewpoint, present procedure is (with a few elaborations) much the same as that employed for the British. The newly-taken blood is refrigerated, and within 24 hours subjected to the drying process. Tested and separated by centrifuging, the plasma is pooled and frozen in a dehydrator at a temperature of 150 degrees, Fahrenheit, below zero. Moisture is extracted by means of a vacuum pump, and the residue—a dry powder—is then portioned out and vacuum-sealed in sterile containers. Each of these, with essential needles, tubing, and a bottle containing specially distilled water, is separately packaged for shipment; the whole comprising one complete operating unit. When it is to be used, the doctor simply mixes the powdered blood with the distilled water—the result being a thickish liquid having about the consistency of condensed milk. He then adjusts needles and tubing, and proceeds with the transfusion.



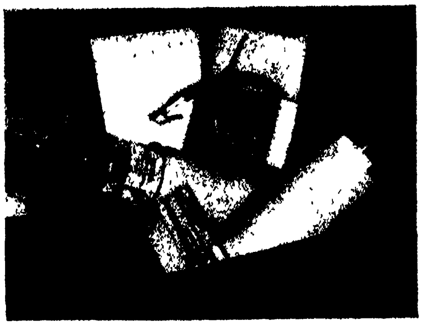
Removing bottles from centrifuge which whirled them at 2500 rpm

As things stand at present, dried or liquid plasma does not serve in every case where transfusion is required. Still greater improvements are hoped for, as may be seen by experiments being carried on with the red corpuscles (wasted in plasma transfusion), in an effort to devise means of putting them to therapeutic use. An additional "conservation note" may be observed in the recent suggestion that corpse blood—from fatal accidents—be gathered for storage against emergencies To the gratification of the more squeamish, however, most medical leaders do not appear to favor this practice, holding that it would necessitate such exhaustive tests and precautionary measures as to nullify its possible value. More likely of adoption is the proposal to accumulate plasma in connection with the Civilian Defense Program—an idea which would seem well founded, since military supplies could scarcely be released for civilian needs

To insure an adequate reserve of plasma for the duration, the Red Cross "Blood Donor Service" is already taking "blood gifts" in an ever-expanding number of cities throughout the country. Several chapters also operate "Mobile Units" which daily visit small communities within a radius of 100 miles of the permanent headquarters, enabling volunteers in these localities to participate Any man or woman in average health between the ages of 21 and 60 is acceptable and there are many who make donations periodically, present regulations specifying that these be spaced at least eight weeks apart, not more than five being permitted within one year Donors are asked to avoid eating for four hours before giving their transfusions, in order to prevent absorption by the plasma of food substances to which the recipient may be alergic.

As you chat informally with doctors and nurses at Donor Service Headquarters, you hear of persons who travel considerable distances in order to give their donations. You hear also of soldiers and sailors on leave, coming in to give their little "extra bit." And of course you hear the irrelevant but classic story of the maiden lady, who, some years ago required a transfusion, but, upon learning that only a male donor was available, declined the treatment—or at least so says the legend—insisting that she would not permit herself to be contaminated by masculine blood.

Dr. Landsteiner, who solved the mystery of the blood groups, back in that other Vienna—the Vienna that was, at the turn of the century—now pursues his serological investigations at the Rockefeller Institute for Medical Research Talk with him in his laboratory and you are profoundly impressed with his patience, his self-effacing modesty In unstudied sincerity, he minimizes the significance of his discoveries, pointing out that his investigations were so basic that it seems strange some other researcher had not embarked upon them long before He tells you, too, that with the increasing acceptance of plasma, which need not be typed before transfusion, the usefulness of his findings will rapidly diminish. And as you listen with respectful interest, you fully appreciate the conscientiousness of these assertions But—you do not accept them



Bottle of plasma, bottle of distilled water, for the Navy and Army

You do not accept them when you ponder the extent of serological and other scientific progress traceable either directly or indirectly to his ground-breaking work.

You do not accept them when you remember the 1500 transfusions administered in London during that sinister, bomb-bedeviled September, 1940.

Nor do you accept them when you contemplate the nearly one and a quarter million units of dried blood with which our own Army and Navy Medical Staffs hope to save innumerable lives in the yet-to-be-fought battles of the present conflict.

No, in spite of Karl Landsteiner's claim that the importance of his discoveries is already waning, you soon realize with increasing clarity that, as a result of his work, America is daily growing more transfusion-conscious, and is turning out in ever larger numbers to do its part toward alleviating the ravages of the dictators on this poor, war-scourged planet.

• • •

BLEEDERS

New Hope for Those Who Bleed Excessively

NEW protection for hemophiliacs against danger of excessive bleeding, and effective help for physicians, surgeons, and dentists in staunching the flow of blood from small wounds is provided by a new, powerful agent for clotting blood recently announced by Lederle Laboratories, Inc.

The new material, called clotting globulin, is the natural clotting constituent of blood separated in highly concentrated form from clear blood plasma (blood from which the corpuscles have previously been removed)

Many persons bleed excessively from minor wounds because their blood contains too little of the clotting principle (prothrombin) This condition may be inherited and permanent (hemophilia), or it may be temporary, the result of the ravages of disease or other causes. When it exists, even slight wounds may become serious through excessive loss of blood No satisfactory method has been known before to control bleeding in persons thus afflicted and even pulling their teeth has involved serious hazard to their lives. Previous treatments employed have included transfusions of normal blood, applications of snake venom (fer de lance), and the use of various substances having hemostatic action.

The new clotting globulin supplies the constituent in which the blood of "bleeders" is deficient and places in the hands of the medical and dental professions an effective means for stopping the flow of blood from minor wounds in a few seconds. The procedure is simple. A few drops of a solution of clotting globulin are applied to the surface of the wound either by spraying or on sterile absorbent cotton or gauze, followed by gentle pressure. By making up the deficiency of the patient's blood, this treatment causes it to clot in the capillary blood vessels within a few seconds.

The method is not effective against bleeding from veins or arteries—this requires surgical treatment—but it has been shown by clinical tests at Boston City Hospital and elsewhere to stop bleeding from minor wounds quickly. Excessive bleeding following the extraction of teeth and the oozing of blood from surgical incisions are stopped within a few seconds by the proper application of clotting globulin.

Clotting globulin possesses true thrombic activity in coagulating the fibrinogen of the blood. It acts by supplementing the prothrombin naturally present. Clotting globulin can be used only locally and under the supervision of a doctor or dentist. Its effect is solely to coagulate the blood at the point of application, and it does not remove danger of excessive bleeding from other wounds.

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ANISEIKONIA—A special study of 400 aviation cadets showed that two out of every 25 men had aniseikonia—a condition which produces unequal images in the two eyes—to the extent of 0.5 percent, or more, according to the Better Vision Institute. Differences in visual images, however, in no case were more than 1 percent.

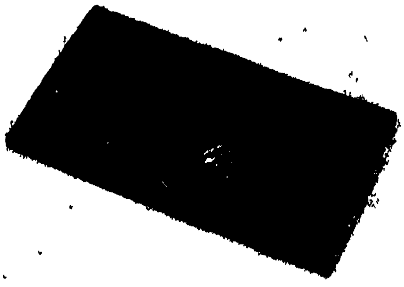
• • •

TIRED FEET

The Home-Made Foot Pad May Help Rest Them

STANDING at work is the most important single factor in the production of industrial fatigue Human feet are much better designed for walking than for standing, in standing on a plane surface, the body weight is constantly borne by the same groups of foot muscles and ligaments. These groups gradually become fatigued and begin to protest.

In an effort to prevent this torment, Dr. Robert Sacks, New York osteopath, has used weight-shifting footpads made by cementing various rubber objects to sponge rubber (dimestore) kneeling pads. "In standing on these I frequently change the position of my feet," says Dr. Sacks. "With each shift of position the feet find a differently tilted plane. In this way the weight is constantly shifted from one group of muscles and ligaments to another; and so no group is subjected to undue strain. This simulates the positions of the feet in walking over turf."



Foot rester

BEAT THE HEAT

Vitamin C Staves Off Heat Prostration

TWO tablets a day are keeping heat-prostration away for many war production workers this summer. The "beat-the heat" pills contain Vitamin C, which physicians of the Du Pont Company's Medical Division have found effective in protecting the human system against heat cramps and prostration, even in places where the temperature rises above 100 degrees and the humidity is oppressively high.

Dr. John H. Foulger, director of Du Pont's Haskell Laboratory of Industrial Toxicology, at Wilmington, Delaware, believes the preventive might well be employed in many other plants, including steel mills, foundries and shipyards, where high temperatures are encountered. It should also prove useful in the engine rooms of naval and transport ships and among troops in the tropics.

The procedure is to give twice each day a tablet consisting of 50 milligrams of Vitamin C and 250 international units of B 1, plus other B vitamins. B-1 is also believed to play a part in protecting against heat attacks but its action, in this particular situation, is not yet so well understood as is that of Vitamin C.

This measure is directed chiefly against the heat cramps and heat exhaustion, or heat prostration, and not against sunstroke or thermic fever, in which there is no sweating and the individual's temperature rises. The two former conditions are by far the more prevalent in industry, however, and prevention of them would save many hours and days of lost time in the production race against the nation's enemies.

An important part of the picture is that Vitamin C is drained from the body in perspiration, just as salt is. Salt pill dispensers have in recent years been installed alongside nearly every factory drinking fountain, so that workers may replace the salt they have sweated out. This has helped ward off heat cramps and heat exhaustion, but many cases have still occurred. Therefore Vitamin C, which prevents other aspects of the condition, should also be given. In other words, salt alone does not appear to be nearly as effective in preventing heat attacks as does a proper combination of vitamins and salt

Little Pictures—Big Savings

Microfilm Has Joined the War Effort, Lending its Advantages to Civilian and Military Uses Alike

LUCILE N. McMAHON

MICROFILM joined the war effort well qualified for a vital task. Its unique services in peacetime to librarians and businessmen are proving of great value to the war industries. Among the more important and timely benefits are: Release and saving of valuable and much-needed space, protection of irreplaceable records against loss from sabotage, bombing, fire or theft; increased availability of all records. Microfilming can serve the interests of every company concerned about any or all of these problems.

This phase of photography is not new, in fact, the process of making tiny reproductions of drawings and documents on film originated during another war. In 1870, Paris was beseiged by the Prussians and cut off from communication with the outside world except by balloons carrying outgoing messages and carrier pigeons for the return mail. These slim threads of contact were the only hope of organizing resistance in the French provinces and of possibly securing aid from other countries. Balloon flights were infrequent, and the weight of mail, particularly incoming, was very small.

Then an idea came to Dagron, a photographer who had been making his living selling opera glasses having a miniature photograph of a Parisian scene on the lens. He printed the messages for the pigeon post on large sheets and photographically reduced them in size until film representing 3500 folio sheets could be carried on the leg of one bird. A strip of his original film is now in the Library of Congress. That was the first recorded use of microfilm for documentary reproduction.

Today, the same principle is used to lighten the load of mail shipments overseas, is being used for soldiers' letters to the folks back home, and our Army and Navy have other uses for microfilm that come within the category of military secrets. But what is microfilm's part in civilian life during war?

Suppose a bomb or a saboteur's torch destroyed the central office of the telephone company—or the light, gas, or water company—and its records, maps, and charts were lost. Civilian life and industrial production alike would be at a standstill until these vital services could be restored; and that would require a long time if there were no engineering drawings from which to work.

A logical precaution is to make duplicate copies of the irreplaceable cable records, maps, charts, and blueprints, and to keep them in bombproof shelters or at inland points where the risk is less. But facsimiles of all such documents would represent a large bulk, and would involve heavy expenses for transportation and safe storage. Even then they would not be readily accessible.

Microfilm best meets the situation. Condensed into roughly 3 percent of the original space, microfilm prints can be sent by air mail to several places for additional safety, if desired. Because facilities for microphotography are readily available and inexpensive, the records can be refilmed periodically and thus kept up to date. Some New England utility companies are now doing this every six months.

The service which microfilm renders to the utilities also meets the needs of concerns turning out war materials. The air-raid menace has caused some talk of moving industrial plants in coastal regions further inland, but that can be done only to a limited degree. For the most part we shall have to depend on anti-aircraft defenses, camouflage, and strict precautions against sabotage to protect our all-essential production. Yet, the most vulnerable spot of all—the drafting room, where design drawings are made, kept, and used—can be further safeguarded.

If fire or bomb should destroy a plant now producing, say, airplane detectors, weeks of valuable time could be saved in reconstructing it if duplicates of the engineering designs were available—details of each complicated and specialized piece of machinery. Drawings in work covering new plant construction, enlargement, and conversion are too valuable at this stage of the race for production to risk their loss by fire, theft, sabotage, or accident.

PUTTING the drawings on microfilm makes it possible to guard them like crown jewels. The Du Pont Company is among those which have taken this precaution. Another firm producing machine tools had some 400,000 charts, occupying 1500 square feet of space, with the number mounting daily. Reduced to microfilm the whole lot could be put into two drawers of a regular letter file, leaving 97 percent of storage space free for drafting-room ex-

Many public libraries are resorting to microfilming of newspaper files in order to conserve storage space and overcome problems of paper deterioration pansion. About 9000 drawings, six by eight inches, were duplicated on a reel of film the manager could slip into his pocket or, more desirably, into a small safe-deposit box.

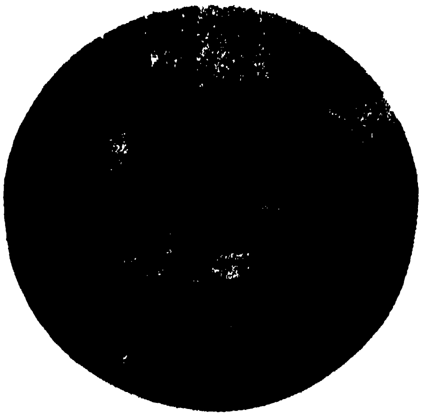
Apart from safety, economy of space itself is a contribution to the war effort, at a time when materials and labor are at a premium. Office space in Washington is so scarce that many employees work in hallways or converted bathrooms. It is estimated that 25 percent of the total space in the Federal buildings is used for storing files. If records in inactive files were microfilmed, with a saving of 95 to 98 percent of this space, not so much new building construction would be necessary. To this end, a recently passed law permits permanent public documents to be thrown away if microfilm copies are available.

Camera that can reproduce on microfilm drawings 20 feet or more long

The importance of microphotography is recognized by the draft-deferred status granted to employees in this field, which was one of the first explored by members of the National Defense Research Committee. Cameras, readers, and film were already on the market. Librarians may take much of the credit for that. About ten years ago, they had found that microfilm was the solution to the vexing problem of what to do with those dusty, crumbling, unwieldy files of old newspapers. As historical records they were too valuable to be thrown away, so their vast bulk was reduced to compact little reels of film that could be kept in drawers instead of storage rooms—that could be consulted and projected to legible size instantly when needed.

Then the practice extended to rare books and manuscripts, in order to make their contents available to readers without wear and tear on the original. Today, the Library of Congress can furnish a microfilm copy, or a positive enlargement, of any part of its nearly ten million volumes. Newspapers from 37 different lands, war or no war, are available through Harvard's microfilm subscription service for other libraries. Brown University has undertaken to film the ancient archives in Latin America. All English books in the British Museum, written before 1500, have been put on microfilm by a project sponsored by American universities. Microphotography has reached the stage where it now has its own magazine, *The Journal of Documentary Reproduction.* More and more libraries have secured equipment, and the development of both apparatus and film has been rapid.

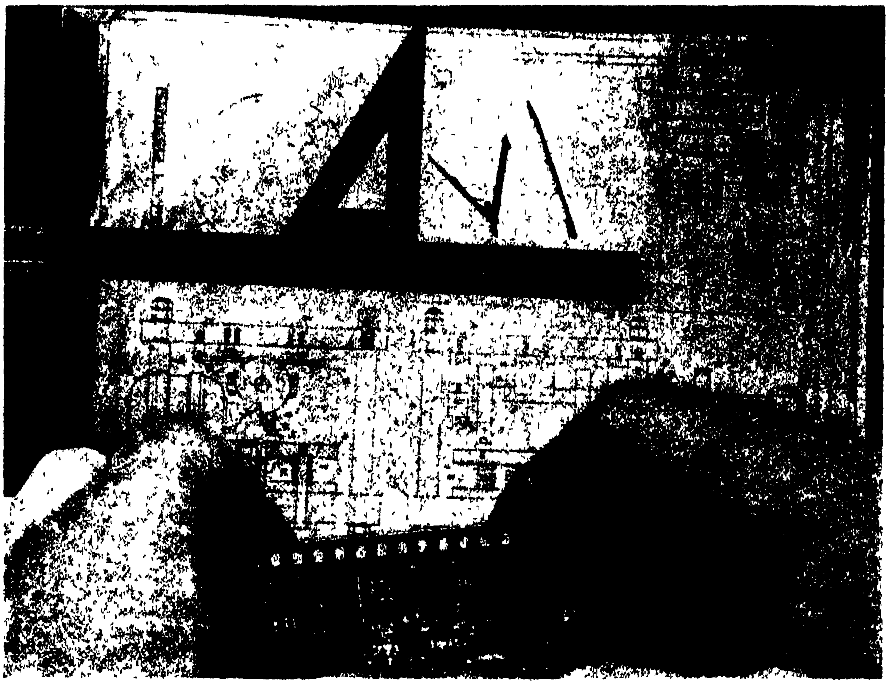
CULMINATING years of research on photographic emulsions, Du Pont chemists have perfected a new type of microfilm which is being introduced to photographers as Du Pont Safety Microcopy. It is described as "an ultra-fine grain, panchromatic, negative film with a high inherent contrast and outstanding resolving power." In case you're not a camera fan, the resolving power refers to its ability to register fine detail. Safety Microcopy permits documents to be reduced to one nine-hundredth the original area and later reproduced to full size without significant loss of legibility. High contrast is important in photographing line drawings and printed matter. By varying the type of developer used, the contrast of the film can be reduced as may be necessary to reproduce screen halftone prints, paintings, and X-ray radiographs. A special treatment of the film emulsion produces a tough surface that minimizes scratches and abrasions, and greatly prolongs the life of films subjected to constant use.



Microfilms, in protecting cans, are stored in a safe-deposit box

You could even put Du Pont Microcopy in your candid camera and microfilm a few of those old love letters in your attic. But if the microfilming job is a big one, you had better employ a company that specializes in such service. For a moderate fee it will not only guarantee the technical part of filming and processing but will also collate and check the material and recheck the film after completion to make sure that it exactly reproduces all of the original material.

The president of one such firm, in discussing microphotography, has this to say: "The hundreds of industrial and business firms which are turning to microfilm for their valuable records now have safety uppermost in their thoughts. But they almost always find



One tiny frame of microfilm—the space between the fingers above—accurately reproduces a complete engineering drawing, such as the one shown in the background

How A Big Business Man Appears To His Wife

"LOOK at him over there, grinning to himself! Strange how little a man can change in fifteen years! The big boss one minute—and like a little boy the next!

"He was mostly 'little boy' before we were married. He'd been coming around for a couple of years, and I'd just about given him up. Then, suddenly, he was very much a *man*, rushed me off my feet and almost before I knew it, we were married.

"When we were newlyweds he was only a bookkeeper, and he'd come home in the evening all tired and discouraged. Other fellows at the office had been promoted, and he didn't know what to do about it. One night I forgot myself and said, 'If *you* don't do anything about it, Mr. Stick-in-the-Mud, no one else ever will!' Then I was sorry, when I saw how I'd hurt him.

"But it must have made him think hard, because one evening the following week he came home looking as though he'd just robbed the piggy bank. He told me he'd enrolled for a course of executive training. He thought I'd be angry, because we were still paying for the furniture. The 'little boy' and the man, all mixed up!

"After that, his whole point of view toward business seemed to change. One promotion followed another, until a few years later he became Treasurer of the company. Now he's beginning to surprise me. Says he expects to be Vice President soon!

"Of course, he's just as modest as he ever was. He'll tell you he got the breaks, but I know better. He *got* the breaks because he'd learned how to grasp them when they came. He's really smart—and so was I when I said 'I do' to a little boy turned man!"

• • •

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other important advantages which are impossible to get with any other form of duplication. I mean economy of space, availability, convenience, permanence, and, when any considerable number of pages is involved, actual cost economy. Banks and insurance companies have already made wide use of microfilm to protect their customers' interests. Department stores are finding that microfilming all invoices is a safeguard which more than pays for itself. Inactive but valuable files of all sorts are being consigned to microfilm Business and industry were discovering these advantages without the added urge to safety which war has brought. War conditions, by causing microfilm to be tried by more people, have only hastened its widespread adoption."

Industry, business, and government are not the only prospective users of microfilm. For instance, hospitals are required by law to keep records covering each patient admitted—ordinarily fifteen to twenty pages each. A large institution like Cook County Hospital, in Chicago, averages 50,000 admissions a year. Many a superintendent wonders how soon the records will crowd out the patients! Microfilm reproduction is the answer for X-rays, charts, laboratory tests, and all the rest. Not only does it save space, but often serves medical research as well. For one medical center may have few or no case records of a rare disease for study, but if the records of several hospitals are assembled on microfilm, the combined information may have more than statistical significance

Music students at the New England Conservatory now study microfilmed scores of symphonies and operas. The Frick Museum in New York has put on microfilm its leading paintings for the benefit of art schools throughout the country. These are but arrows pointing to the vast possibilities of microfilm in education, apart from scholarship

Some day the curator of the Hall of Fame may ask Mr. Gutenberg, inventor of the printing-press, to move over and make room for a French photographer named Dagron!

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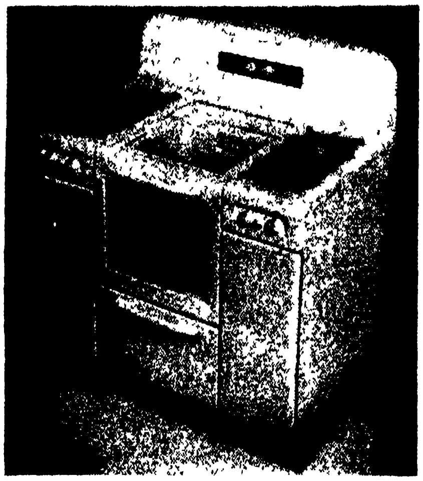
GLASS STOVES

Loom as Possibilities as Result of Research

KITCHEN stoves made of glass have now moved within the realm of post-war practical possibilities as the result of intensified research into applications of new types of flat glass to release critical materials for the war program.

A thought-provoking step was taken when the idea of a glass observation port in a kitchen range door, introduced prior to the war as an innovation to reduce temperature loss and jars resulting from repeated openings of the door to check baking progress, was extended to include an all-glass door.

Intended to increase such vision efficiency, and temperature control, the all-glass door suddenly blossomed as an important idea in metal conservation.



You can watch the food cook

War-stimulated design then expanded the idea to make a vision-top, utilizing the same heat-strengthened Tuf-flex plate glass as was used in the door to make vision possible from above.

A further metal-conservation move came with the idea of using a colored opaque structural flat glass—the very same glass that has become popular as a facing for storefronts, corridors, kitchen and bathroom walls, and other applications—to line the inner walls of the oven, to save more metal. It was then discovered that such a glass-lined oven actually retained heat better and utilized it more efficiently and evenly than metal-lined ovens.

Happy about the whole thing, the glass technicians still weren't satisfied. They used still another type of glass, a heat-strengthened plate glass in translucent color, for the inside back wall of the oven, with lighting back of it, thereby achieving shadowless illumination.

Finally, in their hope to conserve still more metal for the battle fronts, they designed an instrument panel of the translucent, heat strengthened glass (the glass men call it "vitrolux") and thus was born still another use for glass in and on a kitchen range.

Can they go further? The glass boys just grin at that query. Will they go further? Well, not right now. The glass technicians point out that their glass stove design at this time is a sort of after-hours form of relaxation when they are not ears-deep in designs for the job in their and everybody's lap—the job of winning the war.

Still, what they have accomplished, even if it is an after-hour form of relaxation, makes for some fascinating visions of what can be expected in the post-war era — not only the possibility of glass stoves but glass most-anythings.

TRACTOR LUGS

Made of Wood to Conserve Rubber

A PARTIAL solution to the tire problem has been worked out for Kansas wheat farmers in the rationing office of the OPA. When wheat was ripe for the harvest many of the farmers found they could not get tires for tractors and combines, so the OPA office in Wichita had a trial set of wooden lugs built of 3 by 5 inch white oak and attached to the rims of tractor wheels with 3/8 to 5/8 inch iron rods held in place by turnbuckles. The lugs are applied at an angle of 35 to 40 degrees across the rim, approximately 15 to each wheel and are 18 to 24 inches in length, depending on the width of the tractor rim

These substitutes for rubber tires gave the required traction. Cost of the make-shift equipment runs from $35 to $50 a pair While it was only anticipated that the wooden lugs would insure the use of tractors through the present wheat harvest, if the wood is creosoted or dipped in oil they will, in many instances, serve the farmers next year.

RAYON IN TIRES

For Military Use, Conserves Rubber

AMERICA'S army is rolling to war on rubber—and rayon. Rubber has commanded the public's attention, because of the acute nation-wide shortage. But a special type of rayon, an all-American development using only American raw materials, has been conserving important tonnages of rubber.

Tough sinews of this high-tenacity rayon lie beneath the precious rubber skin of military tires—for bombers, combat cars, or transport trucks. Possessing greater strength than any other tire fabric beyond experimental stages, and retaining its great strength under the high heat of heavy-duty driving, this rayon permits tires to have thinner but stronger walls and adds thousands of miles to their life.

The high-strength yarn, developed by Du Pont chemists and marketed under the trade-mark "Cordura," must take an almost unbelievable amount of punishment. The huge tires of the heavy bomber are required to stand up under the jolt of tons of metal landing at high speed, without a blowout. The combat car is driven over the roughest terrain, a severe test in itself, but the Army demands as well that the combat car tire have sufficient structural strength so that, if punctured, it can run flat for many miles so the car can complete its mission or reach a place of safety.

Invention of high-tenacity rayon was the culmination of ten years of research effort to improve the strength of viscose process rayon. It was a high spot, too, in the history of viscose rayon itself, which is observing its fiftieth anniversary this year.

Ordinary rayon is usually made from the cellulose of purified wood pulp "Cordura" high-tenacity rayon is made from the cellulose of cotton linters, the short fibers remaining on the cotton seed after the longer, spinnable fibers have been removed in the ginning. The difference in the raw material is not so important, however, as are certain steps in the process, particularly the stretching of the filament immediately after it is formed.

As in the case of the so-called cold-drawing of steel or nylon, this stretching causes the molecules of the material to line up parallel to one another so that powerful intermolecular forces come into play, which lead to greater strength by preventing the molecules from slipping apart under tension The final product of careful chemical and physical control, and of stretching, is a filament having a tensile strength of 70,000 pounds per square inch In fact, the rayon cord tire has a skeleton as strong, for its size, as the skeleton of a skyscraper.

In building a tire, several dozen cords are unwound simultaneously from a rack of spools (known as a creel) and brought out to lie parallel with one another in a broad ribbon. There are no cross-threads in most modern tire fabrics. They are not woven materials, although the cords of successive plies run in different directions, to give strength. The ribbon of cords passes through a dip of liquid latex, formaldehyde, and resorcinol, which insures a firm union of the cords and the rubber. A layer of semi-soft plasticized rubber is then applied to each side of the ribbon of cords, and is pressed firmly into the spaces between the individual cords. Other plies are similarly built up and assembled, covered with the tread, and the whole vulcanized in the tire mold.

Chief advantage of "Cordura" high-tenacity rayon is that heat does not sap its strength as it does the strength of cotton cords. Consequently it can be used more sparingly in building a tire. Also, the tires are more resistant to blowouts when hot. The walls are very strong but thin. Thin walls dissipate heat and keep the tire cooler. Rayon cord tires average to run 15 percent cooler than other tires. Because the rayon cord tire carcass lasts longer, it can economically take a thicker tread and can also be re-treaded more times.

The lighter-weight tire made possible by rayon cords is of particular importance in aviation, where the tire is needed only for taking off and landing and is simply extra weight during the flight. Obviously the saving of tire weight, to give more maneuverability and sky mileage or to make room for more guns and bombs, is of tremendous importance in military planes.

EXCESS MOISTURE

Absorbed from Air

In Damp Rooms

BASEMENT workshops, photo darkrooms, closets, vaults, laundry rooms, can be kept free of damp and musty air with Dri-Air powder, a chemical

THE NEW NAVY "E"-with-star—awarded first to Bausch & Lomb—is official recognition of continued accomplishment in Production for Victory. It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make.
Watch Out for Tricky Eyes

Vision for Victory

THE future of the world today depends on American industry's capacity to produce the implements of war. The Soldiers of Industrial Production must be welded into history's most efficient fighting organization before the spectre of aggression can be dispelled.

Because most skills depend on efficient functioning of the eyes, and because nearly one-third of the people of the nation still have uncorrected faulty vision, a valuable public service is performed by calling attention of American workmen to the importance of proper care of their eyes.

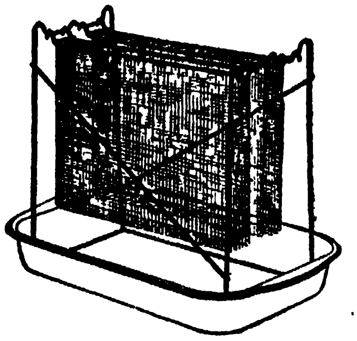
Taking as its theme "Vision for Victory," an advertising campaign (one insertion of which is reproduced above) is now appearing in an extensive schedule of nationally-circulated magazines. The program is sponsored by the Better Vision Institute, a non-profit service association, supported by the manufacturing, distributing and professional branches of ophthalmic science.

We also hasten Victory who make minds keener and hands surer through the improvement of human vision.

BAUSCH & LOMB
OPTICAL COMPANY • ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION

which is exposed to the air at all angles so as to do a maximum air-drying job. After the powder has absorbed all excess moisture in air it remains ready to remove dampness as fast as it forms. The chemical is placed in a special container made up of a one-piece, triple "V" shaped basket, that holds ten pounds of powder. As moisture is drawn from air, the drippings are deposited in a metal pan below the basket.



It makes the air drier

One container is recommended for each 800 to 1000 cubic feet of space. Even the chemical drippings are valuable and should be saved for melting ice on slippery sidewalks and in eaves and waterpipes; it is also useful for settling dust in gravel driveways and for killing weeds.

• • •

SHIP POWER—Over 400,000 Diesel horsepower, including propulsion and auxiliary engines, were installed in 391 vessels added to the United States Merchant Marine in one 12-month period

• • •

ELECTRONIC SEPARATOR

Points Toward Use of Low-Grade Ores

Electronics research engineers recently demonstrated an "electrical spray" that "washes" war-needed metals from low-grade ores, and which may prove to be a valuable aid in easing America's tin shortage. In laboratory experiments the device, a new electrical ore separator, has successfully refined ores of such metals as tin, iron, and gold, most promising results having been attained with low-grade ore samples from a recently developed tin deposit in a southern state. By spraying electrical charges on this ore, which contained only 1.5 percent tin, the new Westinghouse device separated the metal from rock and sand, concentrating it into an ore containing approximately 70 percent tin—suitable for smelting.

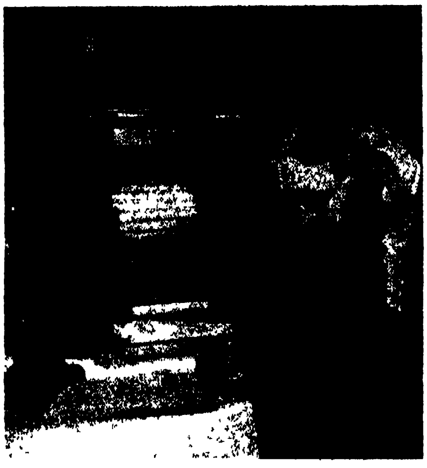
As the foot-wide metal drum of the laboratory model of the separator turned with a surface speed of 12 miles an hour, in the demonstration, it sorted in one minute the 10,000,000 particles making up ten pounds of ore. The particles were deposited in two neat piles. One of these piles contained rock and sand and a small percentage of tin; the other, nearly all the tin, mixed with a small amount of rock and sand.

The ore had been ground to the fineness of sand, dried, and then poured into a trough at the top of the two-foot-tall experimental separator. As the particles of sand, rock, and tin trickled through the bottom of the trough, they fell onto the rotating metal drum, where they received high voltage electrical charges from a series of fine wires a short distance from the drum's surface. Since the tin particles are good conductors of electricity, the electrical charges seep through them and into the metal drum. The tin particles thus lose their charges before the drum has made more than one half turn, and fall off the drum. But the poorer conducting sand and rock particles retain their charges and cling to the drum until pulled off—during the second half revolution—by a series of oppositely charged wires.

Though it is necessary to dry the ore before it can be separated by an electrical spray, the new device may prove to be more efficient than present ore concentrating methods which do not require drying.

Other possibilities for the electrostatic separator arise, since it can sort mixtures of any two materials provided one component is a conductor of electricity and the other such a poor conductor that it is in effect an insulator. In addition to experiments with low-grade tin and other strategic ores, the machine may be used to purify foods.

In foods, the good conductors are usually the ones which contain the most water, and the poor conductors those which contain oils and little water. In trying to separate shells from the meats of nuts, for example, it was thought at first that the dry shells would be poorer conductors than the moist meats. It was soon discovered, however, that because the meats got their moistness from oils, they were little better as conductors than the shells.



Sorts, separates, saves

The Westinghouse research men are now planning tests to separate foreign materials from grains and stems from raisins with the electronic unit.

FLUORESCENT FIXTURE

Steps Up Lighting Efficiency

Development of a new circuit for fluorescent lighting fixtures and a specially designed ballast control unit—a system which makes possible a saving of millions of pounds of critical metals and also improves lighting efficiency—was announced recently by the General Electric lamp department at Nela Park.

Conserves metals, improves lighting

The new fluorescent circuit permits the use of only one ballast—or control unit—with four 100-watt Mazda fluorescent lamps in place of the present 100-watt fluorescent fixtures which require two ballasts for four lamps. The two lamps on each phase of the new circuit start in sequence and operate in series. Thus, one ballast does the work of two, effecting important economies in any fluorescent installation where the new circuit can be used. Although it is designed for use only with 100-watt fluorescent lamps and on 254, 265, and 277 volt circuits, many of the new war industry plants have these voltages available and other plants now being converted to war work can be changed over to take advantage of this circuit.

While the increase in efficiency in producing fluorescent lighting to speed wartime production cannot be overlooked, the saving of critical materials by this new cicuit is of major interest at present. For instance, in one large airplane plant where fixtures using the new hook-up are under consideration and in which more than 35,000 100-watt fluorescent lamps will be installed, engineers estimate that 23,275 pounds of copper, 80,960 pounds of iron and steel, and 3250 pounds of aluminum will be saved. The overall saving in the weight of the ballast equipment would total about 132,000 pounds and a total of 303 kilowatts of current would be released for other war uses

ERROR-PROOF

Radio-Telegraph Printer Put Into Service

ALL possibility of error from defective signals in radio-telegraph transmission is eliminated by a new error-proof radio printer put into operation in the international communications field recently on the direct radio circuit of R.C.A. Communications, Inc., between New York and Buenos Aires. Product of RCA Laboratories, the new printer works with brain-like facility. It automatically rejects false signals and prints an asterisk in place of an incorrect letter.

Present secrecy restrictions necessitated by the war prevent a full description of the printer. RCA Communications officials say that it could be revealed, however, that the device operates with a special code so constructed that a defective character is immediately recognized as such by the printer.

With ordinary telegraph printers as used on the radio, errors may be caused by spurious signals, RCA engineers explain, and this was one of the primary motives that led them to develop the new machine The appearance of an extraneous signal, or the absence of part of the correct one, will cause printing of an incorrect letter on the ordinary instrument. Unless the error is obvious, it may go undetected

CAMOUFLAGE

Art Competes With Photography's Revealing Eye

CAMOUFLAGE of military and industrial installations, which has flourished since Shakespeare's Birnam Wood moved on Dunsinane in the famous sneak-punch attack on Macbeth, has assumed a new and widespread importance as World War II progresses.

Currently referred to as "protective concealment," the art has developed into a contest of wits between the camouflage experts and a new type of military technician known as a photo-interpreter whose duty it is to view aerial photographs of suspected camouflage and endeavor to pick it to bits, a study by the Aeronautical Chamber of Commerce of America reveals.

The essential objective of camouflage is, of course, to puzzle the bombardier, delaying his recognition of his target for the split second that may determine the success or failure of his mission.

Thousands of dollars are daily being spent as America seeks to confuse potential enemy sky bombers and protect industrial plants, factory buildings, railroad yards, airfields, communication routes, conspicuous landmarks, and transportation systems. It is the aerial camera, such as those developed by the Fairchild Aviation Corporation, which has put the old types of camouflage on the spot and rendered the task considerably more complicated—and costly—than was the case during World War I.

While the camouflage technicians aren't revealing many details about newly-devised concealment measures, they will nevertheless talk about some of the tricks of their trade They are using dummy or decoy installations, false highways, considerable smoke or fog-generating equipment, "disruptive painting," and structures built of salvaged lumber, chicken wire, and cheap textiles, artificial tree planting and foliage hung from nets or wire guys. Flood lighting often helps eliminate artificial shadows which do not keep step with the sun's progress. A fixed shadow is a dead give-away to the photo-interpreter who may be studying an aerial photograph of the decoy installations.

Airport installations are often toned down by darkening roofs, runways and taxiways with paint, cinders, or some other medium which will make them photograph the same tone as the surrounding area. Many airport facilities have now been placed under ground and there are numerous tricks for concealing grounded planes. The pilot

TOOLING FOR WAR PRODUCTION

Back of the planes and tanks and guns—back of our entire war program—stands the man behind the machine In the toolroom of a large aeronautical plant, this craftsman at a South Bend Lathe is doing his part in defending America.

The Man Behind— the Man Behind the Gun!

IN TIME OF WAR, the man behind the machine is just as important as the man behind the gun. Back of the production lines of every war industry is our first line of defense — the toolroom. Here, where precision is of the utmost importance — where tolerances are reckoned in split thousandths — you will find South Bend Lathes. Modern in design, built with extreme precision, South Bend Lathes are fast and accurate on the most exacting classes of toolroom work. Their wide range of spindle speeds permits machining with maximum cutting tool efficiency.

South Bend Lathes are made in five sizes—9" to 16" swings, in Toolroom and Quick Change Gear types. We also manufacture Turret Lathes for production operations. Write for a catalog and the name of our nearest dealer.

"HOW TO RUN A LATHE"

A practical reference book on the operation and care of metal working lathes for beginners and apprentices. Valuable as a shop text for training classes. 128 pages, 5⅛" x 8", 365 illustrations. Price 25c per copy postpaid.

DEPT. 569 SOUTH BEND, INDIANA

LATHE BUILDERS FOR 35 YEARS

EDISON STORAGE BATTERIES

Cells are in excellent condition. Complete with solution, connections and trays. Prices below are about 10% of regular market price. Average life 20 years. Two-year unconditional Guarantee.

A-4	Amp. Hrs. 150	Ea.	$6.00
A-6	Amp. Hrs. 225	Ea.	6.00
A-7	Amp. Hrs. 262	Ea.	7.00
A-8	Amp. Hrs. 300	Ea.	7.00
B-2(J-3)	Amp. Hrs. 37	Ea.	5.50
M-8	Amp. Hrs. 11	Ea.	2.00
L-20	Amp. Hrs. 13	Ea.	2.50
L-40	Amp. Hrs. 25	Pr.	4.00

All cells 1.2 volts each

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less an additional charge of 10% is to be added for trays.

U. S. ARMY TELEGRAPH SET

Signal Corps telegraph key and sounder mounted on mahogany board. Operates on 2 dry cells.................. $5.95

U. S. ARMY TELEGRAPH SOUNDERS

All brass on wood base, 20, 50, or 200 ohms Bunnell....... .... $4.95

Lighting Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.

Price $225.00

Additional data on request.

TELEGRAPHIC TAPE RECORDER

Makes written record of code on paper tape. Ideal machine for learning code or teaching code to groups. Radio men can easily adapt it to short-wave receivers for taking permanent records of code messages. Double pen permits simultaneous recording of two messages. Pens operated by battery and key while tape feeder is spring driven. Made of solid brass on heavy iron base. Useful on fire, burglar alarm and watchman systems. May be used to intercept telephone dial calls. 10 ohms.

Rebuilt & finished, like new $47.50 Reconditioned $30.

TRANSMITTING CONDENSERS MICA

operating volts 12,500, cap. 004.

Dubilier, new	$12 50
Dubilier, used	10.00
Wireless Spec. new	$10.00
Wireless Spec. used	$7.50

Condenser, Dubilier, mica. op. volts 8,500. cap. 004 .... $7.50

NICHROME WIRE

in stock
SIZES FROM #39 to .001

U. S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts. $2.95

Single Stroke Electric Gongs

Edwards 12" bronze DC 5 Ohm Mech. Wound	$18.00
Edwards 10" bronze DC 5 Ohm Mech. Wound	15.00
Edwards 6" bronze DC 5 Ohm Mech. Wound	10.50
Schwarze 8" 100 Ohm 32 volt	10.50

Engineers U. S. Army Precision Type Tripods

Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ⅝" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips. Weight 5 lb.

Price $4.95

Build Your Own Searchlight
U. S. Army Parabolic Mirror
Precision Quality

Dia.	Focal Length	Glass Thickness	Price
11 in.	4 in.	¼ in.	$15.
30 in.	12½ in.	7/16 in.	75.
36 in.	18¾ in.	7/16 in.	125.

Made by Bausch & Lomb & Parsons. Perfectly ground and highly polished.

A few 60 in. slightly used metal mirrors on hand.

BAROGRAPH, FRIEZE, 7 Day Graphic, 7 Jewel movement, 28 in. to 31 in. atmos. pressure by 20th. 8 Vacuum Cylinders 3⅝ in. dia. hinge cover, glass front, mahogany case. Price $55.00

U. S. Navy Divers Lantern

Electric 150 watt, any voltage, solid cast brass. 300 lb. test. Weight 12 lb. Price $8.50

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric, Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate. Exceptional value $2.95

U. S. ARMY LIQUID COMPASS (Sperry)

Bronze jewel bearing. Leather case. 2⅝" diameter, 1¼" high $2.50

U. S. Army Engineers Prismatic Compass

Pocket type 360° Limited quantity. $10.50

HUTCHINSON PRISMATIC COMPASS

3 in. dia., brass, black enameled, improved pattern, with opening in top, floating jeweled dial. 2 in. Each... $16.50

DYNAMOTORS D. C. to D. C.

24-750 volt. Gen. Electric 200 mills	$27.50
24-1000 Gen. Elec. 1000 mills	$50.00
12-350 volt 80 mills	$15.00
12-750 volt 200 mills	20.00
32-350 volt 80 mills	9 00
32-300 volt 60 mills	7.50

U. S. ARMY ALIDADES

Hardwood, metric scale, 0-15 cm. and reverse, and log, scale hairline sight spirit level. 45° angle adj. type, made in France $1.95

HAND CLINOMETERS, PENDANT

U. S. Army Engineers, Geologists, Surveying, Mapping, etc. Magnifying Eyepiece. $3.50

"Veeder-Root" Revolution Counter

Six number, (999999) non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special... $7.50

Prisms, Binoculars, Bausch & Lomb, used, slightly chipped, 1 11/16 inch long by ⅝ inch wide $2.00

United States Govt. Fire Extinguishers
(Refillable)
Heavy Copper & Bronze

Carbon tetrachloride (pyrene liquid), pressure type, ideal for labs, trucks, boats, garages, office, etc. (10 times more pressure than hand extinguishers.) Just turn handle. No pumping necessary. Ideal for remote control with wire. (Original cost $40.00.)

1 qt. (100 lbs. pressure)............$10.50
2 qts. (200 lbs. pressure)...........$16.50

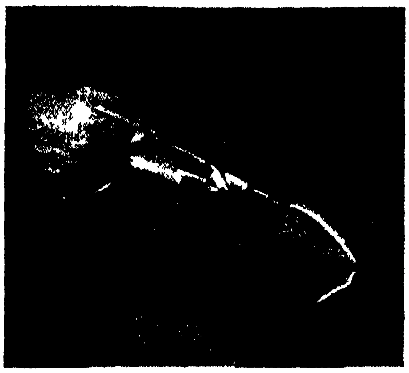
MANHATTAN ELECTRICAL BARGAIN HOUSE, INC., Dept. S.S., 120 Chambers St., New York City

may park his ship under trees out of sight, in foliage-covered tents, or under elaborate netting structures. Aircraft may be parked in gaps cut in hedges so that their wings will carry on the line of the hedge.

METAL CUTTER

Operates From Electric Or Pneumatic Drill

ROTARY motion is converted to reciprocating motion in a metal cutting attachment recently developed for use with any ¼-inch pneumatic or electric drill. Shown in use in one of our illustrations, this Royal Clipper metal cutter, manufactured by E. W. Timper & Associates, will cleanly cut sheet metals up to 040 of an inch in thickness and will cut not only straight edges but will also follow patterns and curves For cutting out sections of panels, the cutter can be started from a ¼-inch hole The blade removes a strip less than ⅛ of an inch in width

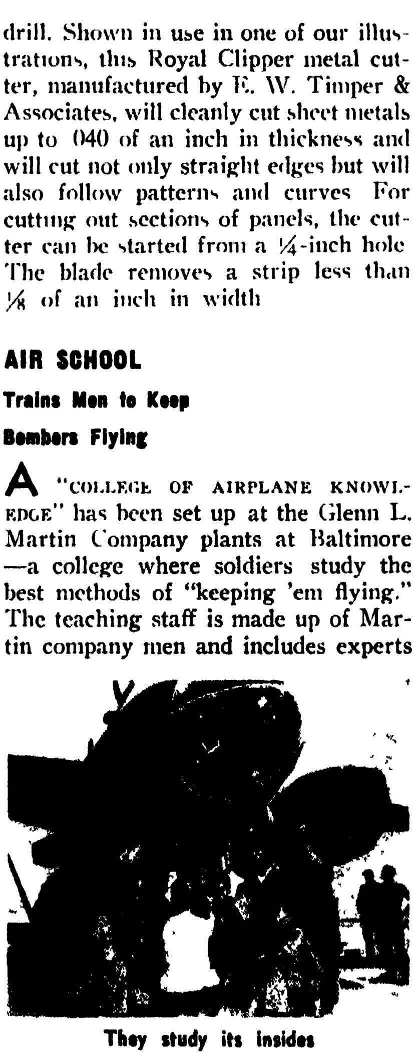


Makes clean, fast cuts

AIR SCHOOL

Trains Men to Keep Bombers Flying

A "COLLEGE OF AIRPLANE KNOWLEDGE" has been set up at the Glenn L. Martin Company plants at Baltimore —a college where soldiers study the best methods of "keeping 'em flying." The teaching staff is made up of Martin company men and includes experts



They study its insides

in hydraulic, electrical, and power installations. Every 12 days 175 graduates of the Army Air Forces Technical Training School are enrolled at the school. These men take a 34-day course designed to teach them to apply in practice to Martin B-26's what they have learned in theory during their earlier training. When they are graduated they know all there is to know about the maintenance of the Martin bomber.

Once they become thoroughly acquainted with the inner workings of the B-26, graduates of the school are assigned to bomber squadrons equipped with this particular type of plane. Wherever the squadrons go, these men who have learned the secrets of maintenance will go also. When the B-26's come home from battle, these mechanical doctors will bandage the wounds and get them back into fighting condition once again. It is one of the vital phases of aircraft warfare.

In the past, one of the most serious problems confronting the Air Forces was based on the lack of trained personnel for maintenance. As production increased, the problem became even more critical Thousands of planes, ready to fight, are of little value unless there is available an adequate supply of maintenance men thoroughly trained in the art of "keeping 'em flying" There must be several ground crew men to each flight crew member.

In adopting this program, the Army Air Forces have moved swiftly. Where could they find better teachers than at the plant where the ships are made? The men who "get 'em flying" also know best how to "keep 'em flying"

• • •

CROSSING DEATHS—Fatalities resulting from highway-railroad grade crossing accidents in the first four months of 1942 totaled 708, an increase of 78 fatalities compared with the corresponding period of 1941, the Bureau of Statistics of the Interstate Commerce Commission points out.

• • •

SEA 'PHONE

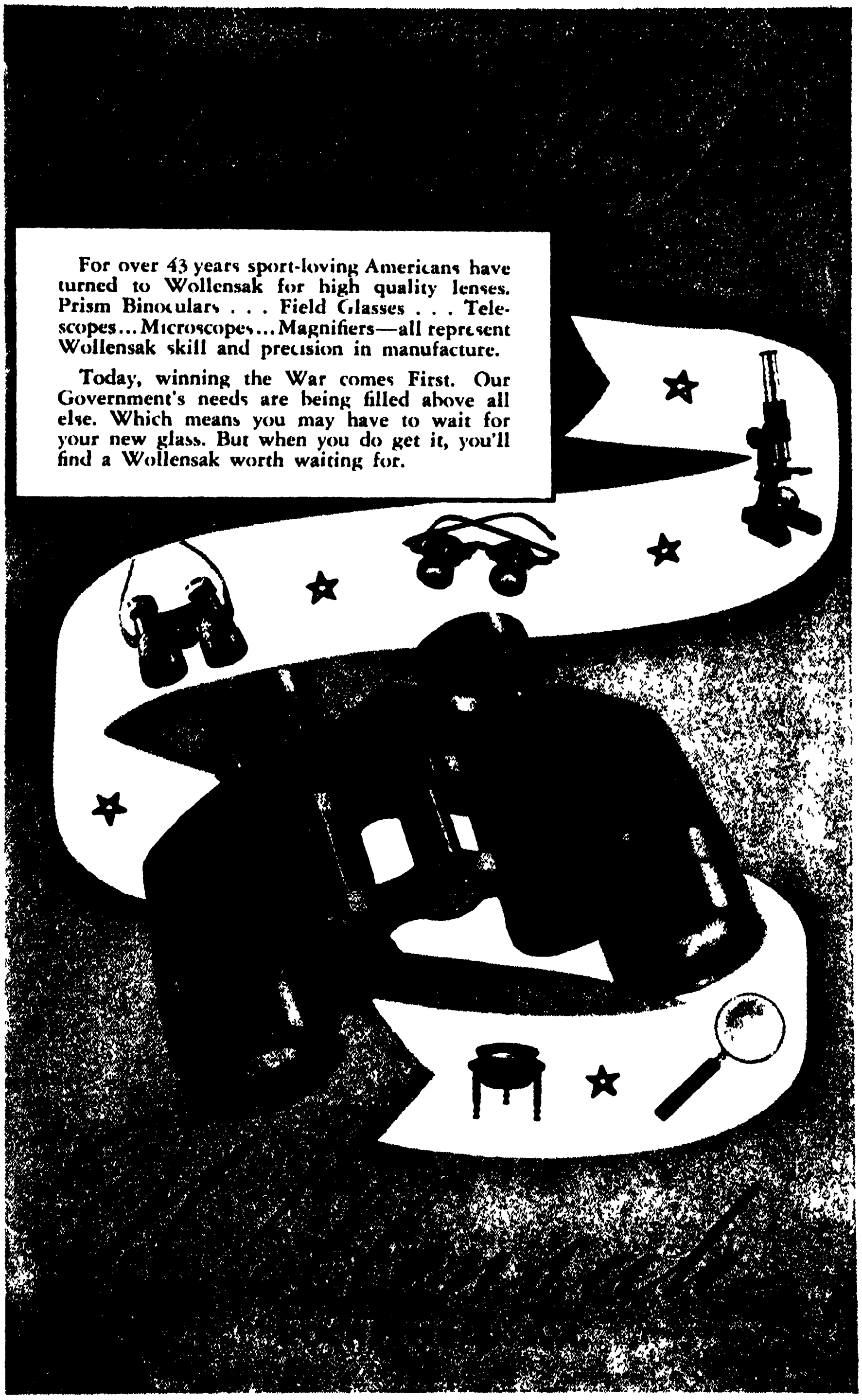
By Underwater Cable, Seen As Possible

A TRANSOCEANIC telephone cable, carrying 12 conversations at once and utilizing delicate vacuum-tube amplifying apparatus that would function on the ocean bottom, is described as feasible by Dr. Oliver E. Buckley, president of Bell Telephone Laboratories.

Such a cable, employing the "carrier" principle, would be much like the coaxial cables now in use between New York and Philadelphia and elsewhere in this country. Vacuum-tube repeaters would be an integral part of the underwater cable. They would be placed at 40-mile intervals, supplied with current by lines within the cable, and would be expected to function for as long as 20 years without attention.

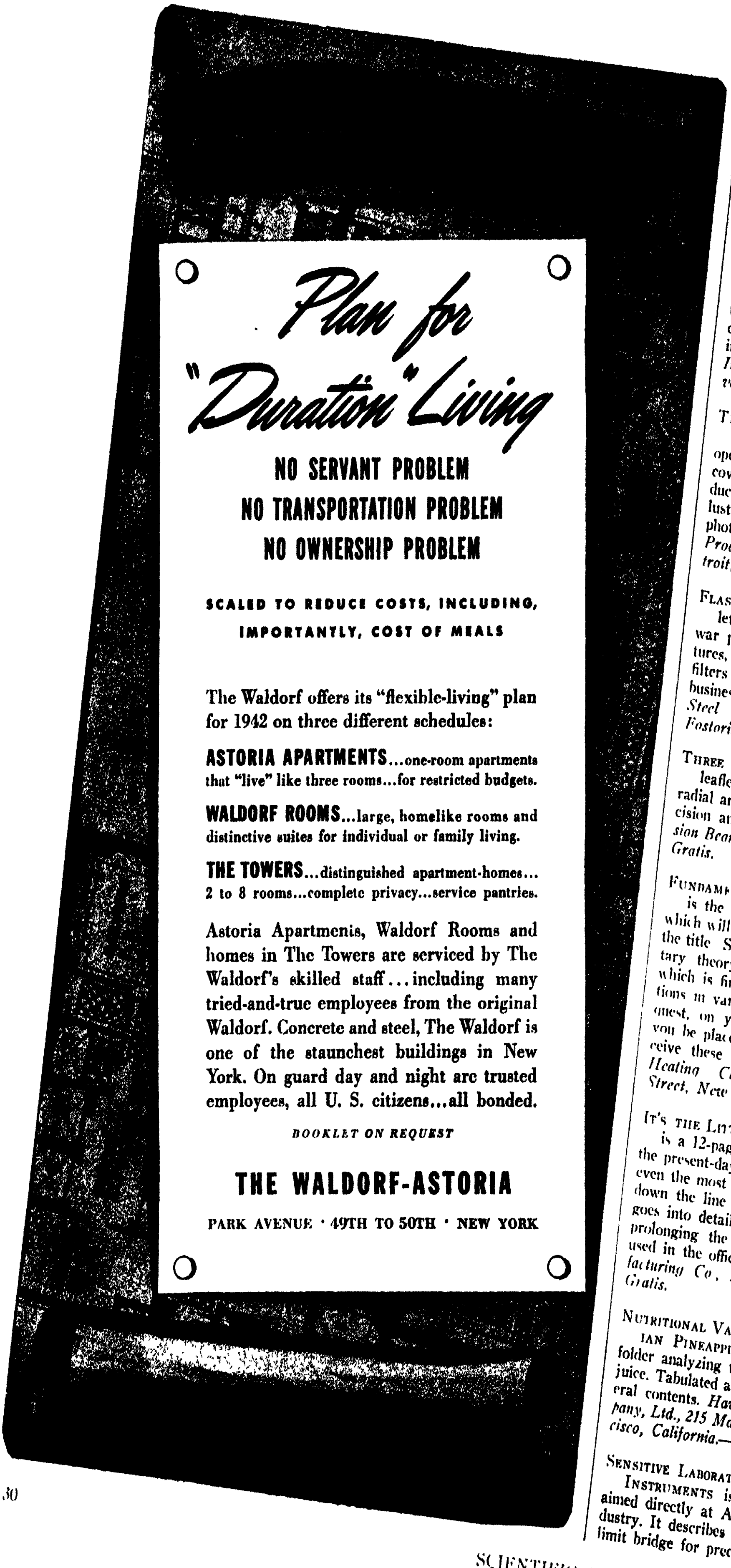
Actual construction of such a cable, Dr. Buckley said, is well in the future because many construction details must be tried out under field operating conditions. He emphasized, however, the need for another type of transoceanic communication system to be used in combination with the radiotelephone channels which are now becoming crowded. It was the strain in the last pre-war years on these radiotelephone facilities that led telephone scientists to resume experiments carried on in the 1920's A short section of such a cable built and tested during the earlier experiments proved technically satisfactory, but the project was abandoned because of the business depression and advances in shortwave radio.

"From purely physical considerations," Dr. Buckley states, "it now appears feasible to provide all of the facilities for telephone connection between all points on the earth that its inhabitants are likely soon to require"



For over 43 years sport-loving Americans have turned to Wollensak for high quality lenses. Prism Binoculars . . . Field Glasses . . . Telescopes...Microscopes...Magnifiers—all represent Wollensak skill and precision in manufacture.

Today, winning the War comes First. Our Government's needs are being filled above all else. Which means you may have to wait for your new glass. But when you do get it, you'll find a Wollensak worth waiting for.



NO SERVANT PROBLEM
NO TRANSPORTATION PROBLEM
NO OWNERSHIP PROBLEM

SCALED TO REDUCE COSTS, INCLUDING, IMPORTANTLY, COST OF MEALS

The Waldorf offers its "flexible-living" plan for 1942 on three different schedules:

ASTORIA APARTMENTS...one-room apartments that "live" like three rooms...for restricted budgets.

WALDORF ROOMS...large, homelike rooms and distinctive suites for individual or family living.

THE TOWERS...distinguished apartment-homes... 2 to 8 rooms...complete privacy...service pantries.

Astoria Apartments, Waldorf Rooms and homes in The Towers are serviced by The Waldorf's skilled staff...including many tried-and-true employees from the original Waldorf. Concrete and steel, The Waldorf is one of the staunchest buildings in New York. On guard day and night are trusted employees, all U. S. citizens...all bonded.

BOOKLET ON REQUEST

THE WALDORF-ASTORIA

PARK AVENUE · 49TH TO 50TH · NEW YORK

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

WHAT ARE WE FIGHTING FOR? is a booklet reproducing a series of advertisements which—clearly, concisely, and dramatically—emphasize America's part in the present-day scheme of things. *SKF Industries, Inc., Philadelphia, Pennsylvania.—Gratis.*

THE JOB IS BEING DONE is a 32-page report to the nation of present-day operations of the automotive industry. It covers completely the industry's war production progress since Pearl Harbor. Illustrated with a number of outstanding photographs. *Automotive Council for War Production, New Center Building, Detroit, Michigan.—Gratis.*

FLASHES, No. 242, is an eight-page bulletin which illustrates applications in war production of localized lighting fixtures, infra-red drying units, and coolant filters Request this bulletin on your business letterhead.—*Fostoria Pressed Steel Corporation, 1219 Fisher Road, Fostoria, Ohio.—Gratis*

THREE NEW ADDITIONS is a four-page leaflet describing new non-magnetic radial and pivot bearings of extreme precision and small size—*Miniature Precision Bearings, Keene, New Hampshire—Gratis.*

FUNDAMENTALS OF INDUCTION HEATING is the first of a series of data sheets which will completely cover the subject of the title Sheet No. 1 presents the elementary theory of this method of heating which is finding more and more applications in various industrial processes. Request, on your business letterhead, that you be placed on the mailing list to receive these sheets as issued—*Induction Heating Corporation, 389 Lafayette Street, New York, New York.—Gratis.*

IT'S THE LITTLE THINGS THAT COUNT! is a 12-page booklet which points out the present-day importance of conserving even the most minor office supplies, right down the line to pins and clips. It also goes into detail on the best methods for prolonging the life of items commonly used in the office. *Allis-Chalmers Manufacturing Co., Milwaukee, Wisconsin.—Gratis.*

NUTRITIONAL VALUE OF CANNED HAWAIIAN PINEAPPLE JUICE is a four-page folder analyzing the content of this fruit juice. Tabulated are the vitamin and mineral contents. *Hawaiian Pineapple Company, Ltd., 215 Market Street, San Francisco, California.—Gratis.*

SENSITIVE LABORATORY AND PRODUCTION INSTRUMENTS is a four-page folder aimed directly at America's wartime industry. It describes a sensitive electronic limit bridge for precision resistance testing, a highly versatile multitester for production line use, and other industrial equipment of similar nature. *Engineering Department, Radio City Products Co., Inc., 127 West 26th Street, New York, New York.—Gratis.*

"CATERPILLAR" DIESELS GO TO WAR! is an illustrated booklet which describes both combat and non-combat use of these versatile tractors. The booklet gives an excellent picture of the wide range of conditions under which they can perform Request Form 7610. *Caterpillar Tractor Company, Peoria, Illinois—Gratis*

HELPING INDUSTRY HELP AMERICA is an illustrated booklet that presents actual case histories of how engineering service, in applying petroleum products in metal working, general lubrication, textile manufacturing, and other operations is speeding up production The facts presented should not go unheeded by anyone concerned with industrial production *Sun Oil Company, 1608 Walnut Street, Philadelphia, Pennsylvania—Gratis*

THE CARE AND CLEANING OF HANDS AND ARMS IN THE INDUSTRIAL PLANT is a 24-page booklet which concerns itself with the problems of the title and with protection of workers against industrial dermatoses One section is devoted to the use of protective creams and another suggests a routine for on-the-job protection *Magnus Chemical Company, Garwood, New Jersey.—Gratis Please request this bulletin on your company letterhead*

BLACKOUT CONTROL FOR MULTIPLE STREET LIGHTING AND HIGHWAY LIGHTING is a series of illustrated articles which gives wiring diagrams for lighting control circuits and presents a description of their application under varying conditions *Automatic Switch Company, 39 East 11th Street, New York, New York—Limited free distribution to engineers, contractors, and operators of war bases and large plants*

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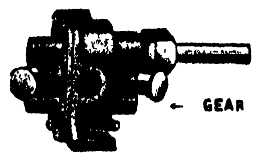

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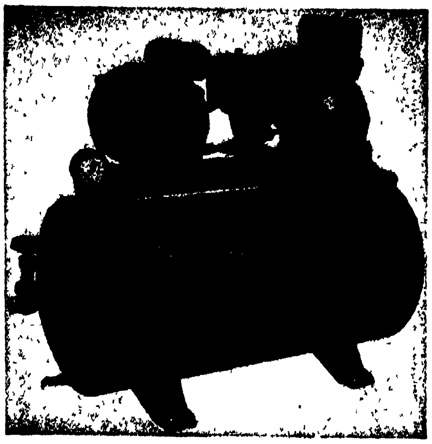

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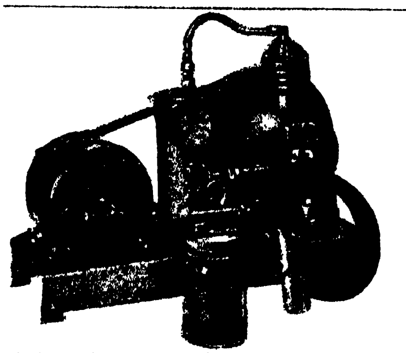

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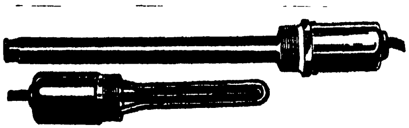

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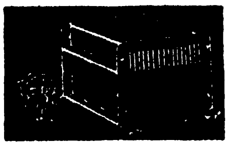

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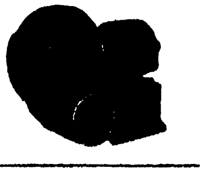

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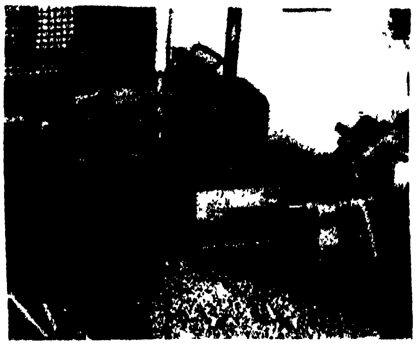
TIME SAVING

Vise Has Turret Jaws to Hold Many Shapes

Tool room and other machinists can frequently reduce the amount of time necessary for turning out a special or a routine job by the use of the turret-jaw vise shown in one of our illustrations. The rear jaw of the vise can be turned through quarter circles, thus presenting four different faces, each of which has a surface adapted for holding various types of work.



Set-up for duplicate drilling

Supplementing these jaws, which are unusually deep, are auxiliary jaws which can be bolted to the tops of the main jaws to hold almost any of the odd shapes constantly encountered in repair and tool work.

With the auxiliary jaws removed, drill or reamer bushings can be attached to the tops of the jaws and, with length stops attached at the sides, duplicate work can be turned out rapidly. The vise, known as the Jackson Time-Saving Vise, is made by the Brown Engineering Company.

PLASTICIZER

For Ethyl Cellulose, Has Excellent Solvent Action

For sheeting, molding, and extruding ethyl cellulose, as well as for use in lacquer films, a new plasticizer known as Theop has been developed by the Glyco Products Company.

Theop is a light-colored, synthetic ester which is commercially available. It is non-volatile, non-drying, non-corrosive and is completely compatible with ethyl cellulose. It has excellent solvent action and will dissolve ethyl cellulose in the cold. In ethyl cellulose formulations for molding, 30 percent Theop exhibits no exuding, discoloration, or other deleterious characteristics, either initially or on aging tests.

SOAP

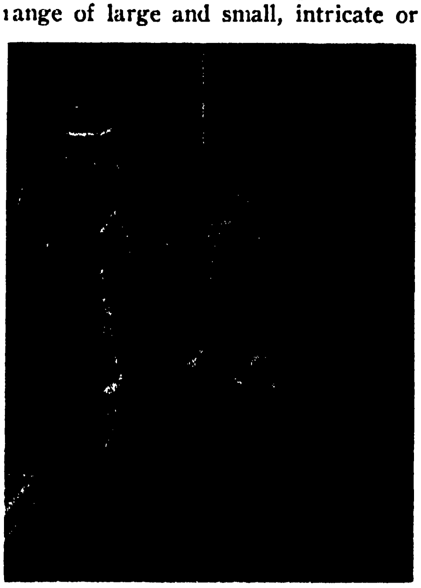
For Commercial Laundries Now in "Complete" Form

Modern washing technique has resulted in the development of a "complete soap" whose introduction is rapidly supplanting the rule of thumb method of mixing soap and alkali, according to researchers of the National Oil Products Company, who have evolved a compounded mixture of anhydrous soap and a series of especially selected alkalies to which have been added solvents and penetrants. This complete soap was prepared for use by launderers in commercial and institutional work where maximum cleanliness, whiteness, and clean odor are essential. It possesses a uniform balance of alkali and soap plus solvent action and penetration.

BLAST CLEANER

Portable, Uses No Compressed Air

Adaptable to the cleaning of a wide range of large and small, intricate or



Versatile in metal cleaning

irregularly shaped work, a new portable metal cleaning unit has recently been introduced by the American Foundry Equipment Company. This blast cleaner, known as the Portable Wheelabrator, is suspended from the ceiling of a blast cleaning room, while objects such as lathe beds, flywheels, furnace castings, and so on, rest upon a perforated flooring or grill. The operator can quickly and easily direct the blast of abrasive from the nozzle of the unit so as to clean completely and thoroughly all surfaces of the work.

The abrasive—metallic shot or grit—is fed through a pipe from an overhead hopper. This abrasive is picked up by a wheel-like element within the unit, and is thrown by centrifugal force out through the mouth and against the work. Hence no air compressors, pressure tanks, or other equipment typical of air-blast cleaners are necessary.

WHEEL DRESSER

Alloy Matrix Holds Diamonds for Life

INDUSTRIAL diamonds embedded in a Carboloy matrix are used in the grinding wheel dresser shown in one of our illustrations Because the Carboloy matrix is virtually impregnated with the diamonds, the dresser becomes a permanent fixture giving the greatest possible diamond utilization per carat, with no resetting expense throughout the long and useful life of the dresser.

Wheel dresser (in circle)

RESIN INSULATOR

Bakes to Coating Resistant To Hot Oils, Water, Alcohol

METALS, fabrics, and various compositions may be given an electrical insulating coating with a new synthetic resin material recently announced by David C. Brown Company. This coating, which requires baking after application, withstands hot oils, salt spray, high voltages, and varying temperatures, is known as Resi-Flex. The coating has high dielectric strength and low power factor; one coat over any clean surface will stand up under 500 volts at 25 amperes.

The original liquid is of low viscosity and is furnished in water-clear solution only. Baking time runs from six to 30 minutes at 275 to 350 degrees, Fahrenheit, depending upon size of unit and type of material

PYROMETER

For Industrial Temperatures, Is Direct Reading

CALIBRATED directly in degrees of temperature, an entirely new type of optical pyrometer is now available for measuring temperatures accurately and conveniently

Telescope of new pyrometer

Optically, this instrument, recently announced by Leeds and Northrup Company, employs the "disappearing-filament" method for precision temperature measurement

The instrument consists of two parts: the telescope shown in one of our illustrations and its attendant potentiometer which is housed in a strong, light-weight casting equipped with straps to be suspended from the shoulders On the potentiometer housing are the electrical controls.

To measure temperature of an incandescent object, the operator looks at it through the telescope which contains a glowing filament. He sees the filament either lighter or darker than its background. While he watches, he adjusts filament current, and consequently brightness, by turning a knob until the filament disappears—matches and merges with the object. Thus he adjusts filament brightness to equal that of the object. A slight turn of a second knob balances the potentiometer which is used to measure filament current, and which is calibrated directly in temperature degrees.

For temperatures from 1400 to 2250 Fahrenheit, filament and object are compared directly. For higher temperatures, the operator introduces an absorption screen.

1917 WAR
RUN BY
TELEPHONE

1942 WAR
RUN BY
RADIO

For Instance . . .

"We would like to have tarried [over Tokyo] and watched the later developments of fire and explosion, but even so we were fortunate to receive a fairly detailed report from the excited Japanese radio broadcasts. It took them several hours to calm down to deception and accusation." (Brig. Gen. James H. Doolittle in news reports of Tokyo bombing)

Interesting!

Watch for radio use in the war news — you'll find it in the air — on the ground — and at home!

WITHOUT radio, the movement of war would still be anchored by telephone lines—the physical hazards of the courier and visual signals.

Now war moves swiftly over the whole face of the earth—instantaneous radio communication thru the ether instead of over copper wires has blasted the barriers of space and time.

So today all our radio production centers on war use.

But what of tomorrow—what effect will this have upon the future—after victory?

One thing is certain—it will revolutionize and speed the great new future form of transportation.

Radio has never been universally necessary in transportation before. In automobiles—on trains—it has been entertainment—in boats it has been a great aid but not an essential.

But today for the future, in that great, new universal transportation that is forming itself—the airplane—radio is essential as the engine itself.

And—mark this well—airplanes and radio are two of the four *great* industries destined to lead this country back to business normalcy after the peace is won.

Zenith's leadership in the radio industry has been established by a constant achievement of "firsts" Repeatedly, ideas "brand new" when Zenith "first" introduced them, later became essentials on all radios And that same "forward thinking" of engineers and factory and organization now concentrates on war production of the thing we know—radio—exclusively radio We are progressing—we learn every day—and this new experience will inevitably reflect itself when Zenith again produces for peace.

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Aircraft Engines Get New Heads

Aluminum Forgings Replace Castings, Speeding Up Production and Releasing Needed Equipment

ALEXANDER KLEMIN
**Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim School of Aeronautics, New York University**

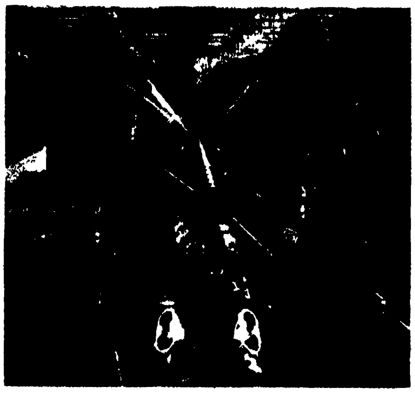
After five years of research, the Wright Aeronautical Corporation has developed a revolutionary technique in aircraft engine manufacture, whereby the aluminum heads of the cylinder are forged instead of being cast.

Here are the striking advantages of the new process: Nine separate drop-hammer operations required with the cast head are eliminated, thus leaving the now critically scarce drop hammers free for other uses in our war production program. Fabrication is speeded up, and there is a very large saving in material rejections. The forged head is much stronger, owing to its closer and more uniform grain, so that higher compression ratios and more power per cylinder become possible In fact, on test the forged heads have withstood hydraulic pressures double those of the cast cylinder heads now in use Still another advantage lies in the fact that the fins can be milled very closely so that cooling is greatly increased, an important point for the aircraft engine with its high specific output Altogether, an increase in power of 12 or 15 percent may be expected which may mean definite superiority in a combat airplane.

In the fabrication of the forging, aluminum bar stock is extruded—that is, forced through a die--and emerges roughly in the shape of the desired forging Then sections of the extruded bar are pressed in a die to final shape. The forged cylinder head and the rough stock from which it is made are shown in one of our illustrations. Hand in hand with the design of the forged head came the development of machine tools which made it possible to turn out these heads much faster and more cheaply than the cast heads. To keep pace with the increased manufacturing speed of the forged head, the Wright Aeronautical Corporation installed many of the huge Greenlee automatic cylinder head transfer machines shown in another photograph. These machines are 154 feet long and combine the operations of 39 older type machines. Originally designed to operate on cast cylinders, the huge transfer unit performs automatic operations on the forged heads without any alteration of the multiple tooling

Forged cylinder head; rough stock

There is, besides saving in time, a saving of valuable material, because 95 percent of the forgings will be turned into cylinder heads, while only 80 percent of the castings made the grade.



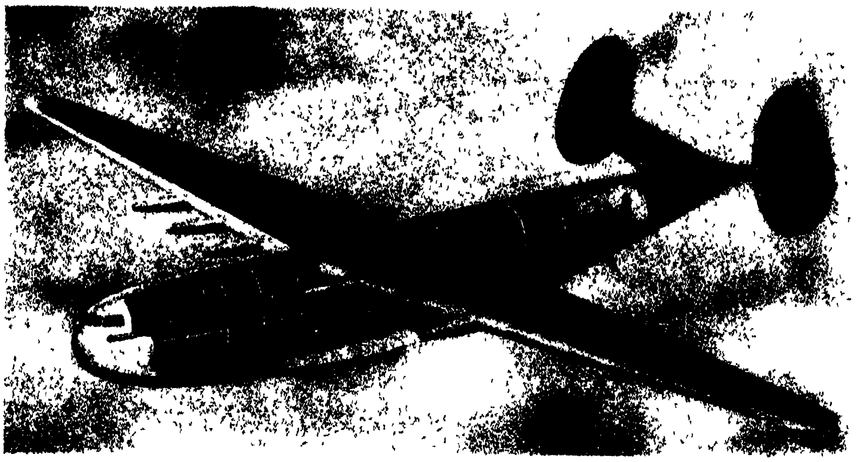
Does work of 39 machines

AIR ADVICE

Needed by the United States Army

Seversky's book, "Victory Through Air Power," has been reviewed so extensively and so favorably, that we shall not attempt a lengthy notice in these columns. We do feel impelled, however, to add the following remarks to the record:

It is quite possible that Seversky may have a feud with the commanding generals of the Army Air Force, but the younger men in the Air Force—the flying colonels and majors who are actually going to do the work of bombing—have tremendous respect and admiration for Major Seversky, They



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approve his analysis of the Battle of Britain; they agree with him fully on the superiority of land based aircraft; they are with him completely on the argument that an air offensive is *the* weapon to be used against Germany. They do not advise him to seek a commission in the Air Force, even with the rank of a general officer At present, so these young and enthusiastic officers say, Major Seversky can say what he pleases and give the nation his immensely valuable views. Once inside the Army, he would be silenced and the United States would lose the benefit of advice from one of the few really noted air strategists of the world.—*A.K*

AIR TRANSPORT

Can Rival Surface Ships in Yearly Volume

ALMOST every day some item of news confirms the view that air transportation is of vital importance to our war effort, and now, under the War Production Board, a committee has been formed to study the cargo plane in relationship to war transport. Grover Loening and other authorities point out that a large airplane could, because of its far greater speed, deliver more goods in a year than a large but slow freighter. The Army Air Transport Command and the Army Air Ferry Command have been combined into one unit. The subject of the towed glider is very much to the fore, and the German Junkers Ju-52 continues to haul men and materials to Libya, with and without the addition of the aerial trailer. Thus the announcement by Glenn L. Martin of a cargo plane of 250,000 pounds gross weight is quite timely.

One of our illustrations shows an artist's conception of the projected giant. Apparently it will be a land plane with six liquid-cooled engines submerged within the wing. It would be capable of carrying 102 passengers, each with 80 pounds of luggage, plus 25,000 pounds of mail and cargo, to London in 13 hours As military transports such planes could carry large numbers of troops and heavy supplies As commercial vessels, they would be able to rival, in a year of operation, the payload carrying capacity of surface vessels.—*A K*

THE "LEANS"

Caused by the Human Ear

A CURIOUS sensation sometimes experienced by pilots, and termed the "leans," has recently been described by Harold G Crowley of the Safety Bureau of the Civil Aeronautics Board. Professional pilots have considerable reticence in discussing this phenomenon; they seem to think that experiencing the so-called "leans" may indicate some physical abnormality As a matter of fact, there is no such question involved, and the sensation may be experienced by anyone. Here's what leads up to it During instrument flight, a slow lateral tilting of the aircraft remains unnoticed and uncorrected up to a certain point When finally the tilting has become pronounced enough for the pilot to be aware of it, he corrects the attitude of the plane in a much shorter period of time than that which was required for the original tipping

Now the human ear is so constructed that it readily notes rapid acceleration but not slow acceleration The ear, therefore, does not recognize the slow tilting but does take cognizance of the rapid recovery motion. The result is that, if the gradual tipping was down on the right side, the pilot ends up with the sensation (called the "leans") that the plane is now tipping down on the left side, even though the instruments tell him that the airplane is on even keel.—*A K*.

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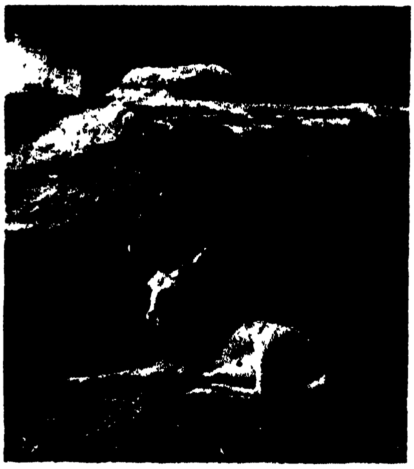
When You Can't Get Close

THE one-lens photographer, which means most of us, has to make that one do for everything, whether close-up or otherwise. What to do at the zoo, for example, when photographers must remain at some distance from the subject, as in the case of the fawn in this picture. You can do one of two things: crop the portion you want, which frequently is not feasible because the wanted material occupies but a small portion of the negative area, or keep the subject relatively small and include the surroundings. The latter usually is not feasible either because so many distracting elements appear. Occasionally, however, inclusion of surroundings lends atmosphere, as well as identifying locale, as in the illustration. A couple of ducks in the water were spotted out, as were also some insistent highlights on the rock. Partial burning in of the upper half of the picture as well as the foreground helped to bring down the tones in these areas and to concentrate the eyes on the fawn.



". . . to concentrate the eyes"

New Exhibit Method

WITH direction by Lieutenant Commander Edward Steichen, U.S.N.R., and descriptive-interpretive captions by Carl Sandburg, an unusual photographic exhibition designed by Herbert Bayer was recently placed on view at The Museum of Modern Art, New York City, under the name, "Road to Victory." The show is not an exhibition in the ordinary sense of the term, which is understood to mean a collection of prints on mounts displayed uniformly on a wall, but something more in the nature of a still travelogue of America's resources and how these are being put to use in the gigantic war effort to back up "the man behind the gun."

The unique feature of the show is the variety of display ideas. The majority of the pictures, all of which were taken from the files of governmental agencies, large news picture agencies, and other sources, are huge enlargements, or murals. The arrangement is given a three-dimensional atmosphere by such devices as suspending prints by wires from the ceiling, by arranging the pictures on the floor suitably tilted for convenient viewing, by ingenious juxtaposing of prints on walls and floor, by a planned viewing sequence routine, by the use of railings to fix the viewing distances, and other means.

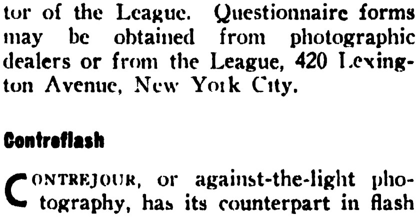
A copy of a booklet containing many photographs showing the arrangement of the show as well as the text, can be obtained by writing the museum at 11 West 53rd Street.

Where Have You Filmed?

IF you have ever taken travel movies, still pictures, or transparencies outside the United States, your Government is interested in what you have. Your pictures may be instrumental in helping win the war. Such pictures sometimes prove invaluable in piecing together vital information. Acting on the request of authorities of the United States Government, the Amateur Cinema League, Inc., has assumed the task of soliciting these pictures and to make them available to the Government. "Quality is unimportant; subject matter is paramount," writes Roy W. Winton, managing director of the League. Questionnaire forms may be obtained from photographic dealers or from the League, 420 Lexington Avenue, New York City.

Contreflash

CONTREJOUR, or against-the-light photography, has its counterpart in flash work. One example is illustrated. The flash reflector was used on extension, and the legs of the foreground subject, the "frame," provided the necessary shield. As a result, the photographer and camera were in perfect silhouette, while the photographed subjects received the illumination. This technique lends itself to many variations and has frequently been employed for unusual effects in flash photog-



The frame provides the shield

raphy. As in contrejour work, two important precautions must be watched: make sure the light does not hit the lens; shield the light appropriately so that it does not spill over into the area that is to remain dark.

Hair Aids Composition

In composing portraits, the hairdress of the woman subject usually receives little attention aside from the use of a spotlight to give sparkle and body to the hair and to provide separation from the background. Sometimes, however, it is possible, in the case of subjects with long tresses or curls, artificial or otherwise, to make use of hair in arranging the composition a little differently from the ordinary shot. In the present instance—a portrait of the ballerina, Miya Slavenska—the curls resting on the shoulder not only help the arrangement but are almost necessary in view of the pose. The tilt of the head is on the border line between strain and naturalness; the curls seem to relieve strain and help balance the composition at the same time.

"Portrait of a Ballerina"

Reducing Chemical Fog

If you have been consistently getting aerial or chemical fog in your negatives, the fault may be minimized by adding a little desensitizer to the developing solution. Be sure the desensitizer is the type that may be mixed with developer, such as Pinakryptol Green.

Separation Negatives

Some beautifully done color prints we saw the other day, at a demonstration of color printing, gave us revived hope in the future of color photography for the general worker. The results left nothing to be desired. As one person remarked, they were "better than paintings." However that may be, satisfaction was universal. Nevertheless, the question was put to the demonstrator: "The separation negatives from which you are working were made in a one-shot color camera, of course?" intimating that separations made from Kodachrome transparencies could not have produced such excellent color values in the print. "Not at all," said the demonstrator. "While it is more convenient to use the one-shot color camera and thus obtain three separations direct and at one time, I personally prefer to make my own separations from Kodachromes because then I can control the exposures for the individual separations, whereas in the one-shot I have to take what I can get, which is frequently a compromise."

ASA Computer

Designed for the Army and Navy photographers for use in any part of the world, any time of the year under all daylight conditions, a Photographic Exposure Computer, produced by the American Standards Association, is now available for civilian use as well. A 24-page booklet with fabricoid cover, the computer has a movable dial calculator which correlates light condition, the scene's reflective powers, and the speed of the film used, offering the photographer a choice of lens stops and shutter speeds for the particular conditions involved. Compiled from observations by the Smithsonian Institute and the United States Weather Bureau over a period of years, the computer includes tables indicating the amount of light available at any point on the earth's surface for a given month and hour, as well as other useful data.

Opposing Diagonals

Group pictures, especially when taken semi-candid-wise, as this one was, are not easy to compose. In this flash shot of Bruce Downes, newspaper editor and camera columnist, and his wife, Bruce sat on the arm of the chair and leaned over at a rather acute angle. When someone cracked a joke, both looked his way, the lady characteristically tilting her head a bit, with the result that the camera caught two sprightly diagonals. Spontaneity of pose and expression plus unusual composition were both well served.

"Laughing Diagonals"

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A KNOWLEDGE of many types of blueprints is necessary for the electrical worker. Hence the text of this book, after describing briefly how blueprints are made, is presented in nine sections. These are concerned with architectural blueprints, diagrams for bell and signal wiring, administration building blueprints, automobile wiring diagrams, diagrams of generators and motor symbols for control diagrams, motor control diagrams, and power station blueprints. Complete explanations are given of all the various symbols used in these different types of blueprints. In a pocket in the back of the book are nine typical full-sized blueprints (318 pages, 6 by 8½ inches, a large number of diagrams and photographs pertinent to the text.)—$3.10 postpaid.—*A.P.P.*

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By Hugh Allen

THE present war has certainly shown that the non-rigid airship has a definite sphere of its own in submarine patrol near our coasts. Mr. Allen's brief historical review is therefore very timely. It is technically correct but also manages to be concise, interesting, and informative. Modern improvements in the airship are well covered. The story of the Goodyear fleet in commercial operation indicates that there are real possibilities for the small, lighter-than-airship in peacetime activities. Finally, Mr. Allen describes fleet operations and also discusses the vulnerability of airships. There is no doubt that utility in submarine patrol is definitely proved by the author and there is even some argument in favor of huge airships to act as a species of aircraft carrier. While Goodyear activities loom a little large, this is still a book of considerable general interest. (74 pages, illustrated)—$1.10—*A. K.*

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AIR RAID SHELTERS

By A. D. Rathbone, IV

(Continued from page 117)

rent when it is remembered that, of the 168 hours in the week, the average citizen works at his place of business 40 to 48 hours, and spends 12 to 20 hours in the streets and other public places, and the remainder of the time (about 100 hours a week) at home. This means that during the weekly cycle of urban life the chances are about three out of five that if the community is bombed, the attack will occur while the working people are at home. Actually, the chances of an individual being bombed at home are even greater than three out of five, since the large majority of the urban population work in the daytime, whereas most air raids are carried on at night, and since the non-working members of the family spend an even larger percentage of their time at home."

For the householder, there are three general methods of shelter protection: (1) Underground, either in the yard or beneath the house; (2) surface, or semi-surface, either attached to or inside the house; (3) a "refuge" room. The latter is not as effective as the first two, especially in houses of light, wooden construction, but it is much less expensive and can be accomplished by anyone with a little ingenuity. In this latter category comes the British Morrison "mouse-trap," regarded in the opinion of some professional engineers as the most adequate indoor method of protection. Designed for ordinary use as a table, the Morrison has a steel roof, or top, mounted on steel legs. It is 30 inches high, four feet wide, six and one-half feet long, its sides are of steel or heavy wire mesh, and it will accommodate a man, his wife, and one child. This offers only emergency and primary protection from falling debris and should not, therefore be expected to withstand more of a load than the collapse of an average two story dwelling. By the same token, there should be no cellar or other excavation beneath it into which it could fall.

A British type of semi-surface shelter, the Anderson, is shown in one of our illustrations. These are constructed in various sizes, they have proved reasonably safe and satisfactory as protection against bomb blast and splinters, but they require a considerable amount of heavy galvanized sheeting, or elephant iron, to build. An American commercial prototype of the Anderson which obviates the use of our precious steel supply is The Solid Timber Shelter, made in either table form or arch shape, the latter, being shown in one of our illustrations. Both are designed for indoor use, and it is claimed the arch shelter has withstood tests which prove it capable of protection against 10 tons of debris, while the table style is reported built to take almost double the load of the Morrison. Constructed of four-inch timbers, either type is designed to safeguard dwelling occupants from dangers of falling debris, flying glass, and, to some extent, bomb concussions. Any house type of shelter, either indoor or outdoor, helps in the vitally important problem of keeping the civilian population thinly spread out during an air raid and of keeping parents and children from becoming separated.

As to private shelters in yards, just about anything from an open trench, wide enough and long enough in which to lie flat, to the more complicated, more expensive steel (if you can get it), concrete, or sheet-iron constructions will provide splinter protection and reasonable safety from the devastating blast of a bursting bomb. Although bombs in this war are bigger, more destructive, and more varied in type than in the last conflict, this writer inscribed the following in his diary under date of August 21, 1917, after his first experience with German bombs, and it is as applicable today as then: ". . . every man who could conscientiously leave his post ran like mad for cover. 'Cover' usually consisted of throwing oneself as forcibly as possible upon the ground in a gutter or close to a building. The man who could throw himself most forcibly and cling the closest to earth was the safest." That technique, in the absence of any form of physical protection, is still recognized as good—and it requires little or no practice to attain perfection!

As to modern office buildings, skyscrapers, apartment houses, the problem is different and varies with the structure. Again, and above all else, obey the regulations established for your particular building, keep cool, and obey the warden in charge. Go to any interior rooms or hallways above the first, and preferably above the second floor, but avoid the roof and upper floors. If no interior rooms are available, stay away from windows, but open them.

Lack of space prevents presentation of complete details on this many-sided subject of civilian protection in case of enemy air-raids. There have been, however, a number of excellent books published, some technically inclined for guidance of those responsible for providing safety to the public, and others designed primarily for public consumption. The Office of Civilian Defense in your locality can also help.

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TELESCOPTICS

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Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

As THE little note on page 98, explaining the cover picture, states, the 200" telescope on Mt. Palomar, California, is now locked up tight as a drum for the duration of the war. The former working force is doing things that directly help win the war, in order that we may continue to have astronomy according to science and not according to the Nazis No doubt, if the Nazis won, all the astronomies would be called in and burned, and new ones issued teaching all coming generations that the Sun is Hitler in Heaven.

George Herbig, one of the more prominent amateur telescope makers in Los Angeles and now connected with the Griffith Observatory (planetarium) there, writes that he visited Mt. Palomar Observatory before it was closed up, and took the cover picture.

This is no ordinary photograph. As anyone knows, who has tried to photograph a telescope within its observatory dome, it is most difficult to obtain points of view that take in the whole instrument—usually one gets only various parts Herbig did not knock out one wall of the building, but luckily found the yoke and tube so positioned that he could shoot partly upward from below and get an excellent general view of the whole. The ladders propped against the mounting give the scale. The object in the lower left foreground is the aluminizing tank—really a gigantic affair, Herbig states.

There is no use arguing that the 200" is beautiful. It's a plug-ugly, like a big square-toed, hobnailed boot. But it wasn't designed for sex appeal. Functionability was the true governing principle in the design and no real sacrifices were made to beauty, as this would be criminal. So it's simply a he telescope, unashamed

Figure 1 shows the main worm wheel for the R. A. drive of the 200" telescope This is 11' in diameter and the spacing error of the teeth is one second of arc, or one part in about a million and a half The man shown worshipping is M. K. Baughman, technician of the Griffith Observatory. George Herbig took this photograph also.

GENERALLY, in precision optics, surfaces are worked to a tolerance of one eighth of a wavelength, or around 1/400,000". But not all of them. Suppose light is to be reflected from two surfaces, serially; or three, serially. The tolerance then becomes smaller. The 200" mirror, for example, is to be worked to a tolerance of 1/20 wavelength—just about a millionth of an inch. This is to be done because in certain combinations of its auxiliary mirrors there will be six reflections, serially

This 1/20 wavelength is simply an attenuated case of the famous Rayleigh tolerance, described in Conrady's "Applied Optics and Optical Design." For one reflecting surface the tolerance is ⅛ wavelength. For n surfaces in series it becomes $1/(8\sqrt{n})$ and where there are six reflections this is approximately 1/20. Summarizing the matter, H. H. Selby says in a letter:

"Maximum phase difference at ultimate focus for all rays should be less than ¼ wavelength, ⅛ for perfect definition.

"Assuming a smooth surface, a zone one wavelength out of position will introduce two wavelengths' path difference at focus, for one reflection.

"If $(n-1)$ surfaces are interposed between the first surface and the focus, least squares treatment indicates that a total of n reflections will have an average of the square root of n effect.

"Assuming that each surface adds an error in a common direction (either plus or minus), the summation of path differences must be less than 1/8 wavelength, and the first surface must contribute no more than $1/(8\sqrt{n})$. For six reflections this is approximately 1/20 wavelength"

All of this being the case, but often lost sight of, it seems that where two surfaces are involved, the tolerance should be pushed up a bit, to about 1/11 wavelength—at least where perfection is the high aim. It is one argument against tackling Cassegrainians lightly.

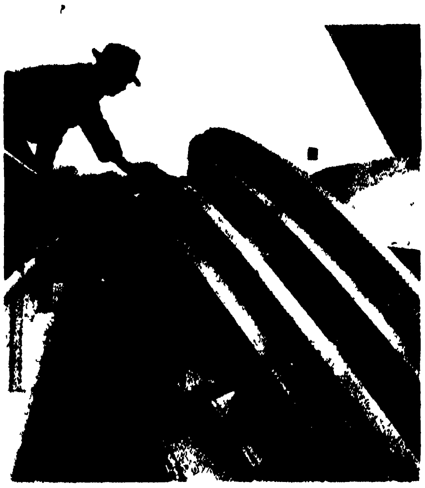


Figure 1: **Worm wheel of 200"**

OWNERS of the book "Amateur Telescope Making—Advanced" will recall, in that book, page 319, a description of a drive for a fine 12½" telescope made by Alan Gee and C. Carvel Diller, the former then a cadet at the West Point Military Academy. Gee, now a Captain in the 18th Engineers at Vancover Barracks, Washington, where he is working on a 20½" Cassegrainian in conjunction with two Portland amateurs, sends in the following, with the statement that by the time it is in print he may be elsewhere.

"Here is my contribution to the Cassegrainian secondary problem.

"It is impracticable to test the hyperboloidal convex through the back, so as to consider it a concave However, it is practical to test a concave hyperboloidal test mirror and then use this mirror to test the convex by means of interference fringes

Figure 2· **Gamble's ideal hideout**

"What I propose is this. Determine radius of curvature of the secondary by the usual method Grind and fine grind to this curve Then set aside the convex mirror and polish the tool, which of course is of the same curve as the secondary except it is a concave. The tool need not be polished to the perfect degree required of the finished secondary, but should be fairly well polished.

"Then figure the concave tool to a hyperboloidal curve, using the good old Foucault test and the following formula to determine the radii of the various zones

$$R = \frac{(P' + P)^2\sqrt{r^2 + P'P}}{2(P' - P)\sqrt{P'P}} - \frac{(P' - P)}{2}$$

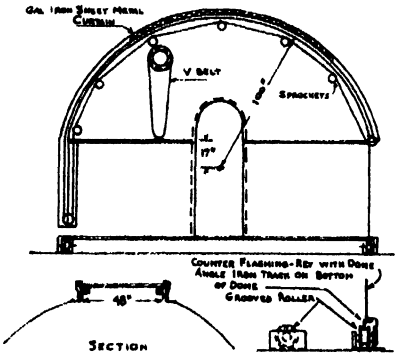
[The symbols are the standard ones of Ritchey—see "A. T. M.," page 62.—*Ed*]

"Obviously, the same procedure would work for testing the spherical convex of a modified Cass. The test mirror would of course be figured spherical.

"This method sounds long and difficult, but remember that you already have the concave test mirror fine ground to the correct radius, and that only a few hours of polishing will be sufficient to permit figuring and testing by interference fringes. Also the test mirror need not be wasted after the job. It can readily be refigured into a good paraboloidal primary.

"I inclose my derivation of the above formula in case some of your math nuts would like to try to pick it apart." [Available to math maniacs, on request.—*Ed.*]

Gee says he and his co-workers are using this test on the 6" secondary of the 20½" mirror, which is an old Tinsley replica of the 200" mirror with prime focus 80". Secondary focus is to be 240", hence overall *f* ratio is about 12 English type mounting. Split ring outer bearing, allowing the Pole to be reached It will be extremely heavy and rugged, he adds


Gal. Iron Sheet Metal Curtain
V Belt
Sprockets
17"
Counter Flashing-Rev with Dome
Angle Iron Track on Bottom of Dome
Grooved Roller
48"
Section Thro Slot
Roller Detail

Redrawn by R. W. Porter

***Figure 3:* Gamble's dome details**

On a bluff just outside Moline, Illinois, overlooking a valley and with an excellent horizon, stands the observatory shown in Figure 2, built by Carl H Gamble, R.F.D 1, that city. It contains a 5½" Zeiss refractor on a Clarke mounting

Lower story of the observatory houses the owner's science library in a room 18' by 20', which also will accommodate the members of the local club of amateur astronomers. Above is a deck 22' by 32', and on this is the spacious dome, 16' 8" in diameter—just the size, by the way, of the 200" *mirror* in California!

Details of this neatly designed dome and slot cover are of especial interest (Figure 3) The former is a steel silo top made by Lanneck Products, Inc., Middletown, Ohio—similar to domed silo tops made by a number of manufacturers For example, The Independent Silo Co., of St. Paul, Minn. Entire dome rotates on eight rollers near the floor level, the conventional fixed wall thus being eliminated In this respect it is similar to the type shown in "Amateur Telescope Making—Advanced," page 493, Figure 13

During the soul-trying work of making a first telescope mirror, when it is altogether natural to entertain misgivings whether the claim that an amateur can make his own telescope mirror is true, something is needed to bolster or shore up the morale of the poor, lonely, and perhaps wavering worker

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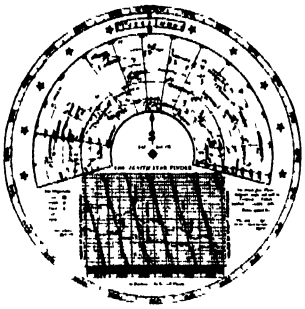

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TELESCOPTICS

The famous Brashear, in his Autobiography (page 49), tells of doing this. I, too, have done it. Sunspots can be studied (always using two pieces of smoked glass between eyepiece and diagonal), the Moon's major features can be seen, likewise the phases of Venus. I saw all those fairly well when the figure still was a rank hyperbola. It renewed my courage."

The tyro may, however, encounter one lesser discouragement in connection with doing this—collimation of the mounting to hold the mirror. This usually is a tough, cussed job. Perhaps, if told in advance that it usually is such, and thus led to expect it—for most owners have been through that same mean stretch and few have found it otherwise—this setback to morale won't seem so big

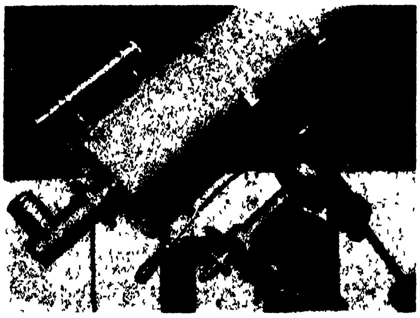


Figure 4: **Coates' 8" Gregorian**

After completing an 8", *f*/8 Newtonian, a 6" Richest-field telescope, and a 10" Gregorian (Figure 4), Ernest L. Coates, 6432 Perry Ave., St. Louis, Mo., built the attractive backyard observatory shown in Figure 5.

He made the patterns for the castings used in the mounting of the Gregorian and had the castings made and machined outside. The telescope has a motor drive and is equipped with setting circles. Coates made a battery of eyepieces, from ⅛" to 2½" efl, using Crystallex glass obtained from the Pittsburgh Plate Glass Company, and found this choice, clear, plate glass sufficiently satisfactory. The Gregorian proved to be successful—sharp images—but Coates finds the field of view rather small, the only complaint he named.

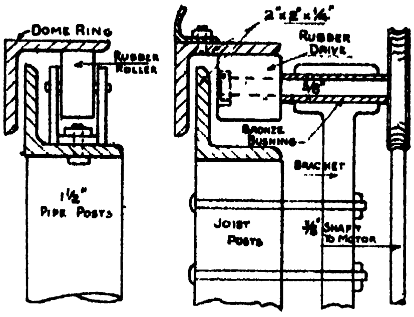
Figure 5: **The Coates Observatory**

The Coates Observatory is all metal, 10' in diameter, and is supported on eight 1½" iron pipes set in concrete. Its sides are of 26-gage galvanized iron. Both circles—the one on the dome and that on the fixed base—are of iron and are welded in one piece. Dome ribs are 1/8" x 1" flat iron stock. The one-piece shutter rolls to one side on grooved rollers running on angle iron track and Coates states that it does not clog with ice. A 1/6 horsepower motor rotates the dome at one turn in two minutes.

The dome is mounted (Figure 6) on 18 rubber rollers and is noiseless when moving. There are six guide rollers to hold it in position. The slot opening is 30" wide. The drive (Figure 6) is of the friction type.

The dome is painted dull black inside (lampblack, alcohol, enough shellac for binder), and with aluminum outside.

Profanity is traditionally the chief by-product of making a pitch lap—at least during the first 10,000 attempts. New stunt (so far as is known) is offered by A. Rowland, 909 Easton Bldg., Oakland, Calif.



Redrawn by R W. Porter
Figure 6: **Coates' dome details**

The two disks are warmed, the face of the mirror disk is given a thin coating of common vaseline, and the two disks are stood on edge, side by side, separated by the thickness of the desired lap, on a strip of heavy adhesive paper. Next, the paper is rolled around the disks and is stuck fast to them. Some kind of props can be used to hold the disks in place for the pouring, if desired. A pouring cup or funnel, of modeling clay, is set on top, over a hole punched in the paper, and the melted pitch is poured in till it reaches the top and ceases to settle. The whole unit is then set in a cool place for the pitch to set *fully*

To remove the mirror, Rowland states, he first rests the unit on small blocks in a basin, with the mirror disk down, and then pours in enough cold water to submerge its lower half. He brings the water slowly up to about 100° (average hand-washing water) in not less than 20 minutes—otherwise, risk of cracking. He next removes the unit, lays it on a bench, tool side down, and places a strap or strip of cloth around the tool, half a turn with the two ends extending in the direction of an assistant whose job is to hold them. Then he places a similar strip around the mirror and pulls in the opposite direction.

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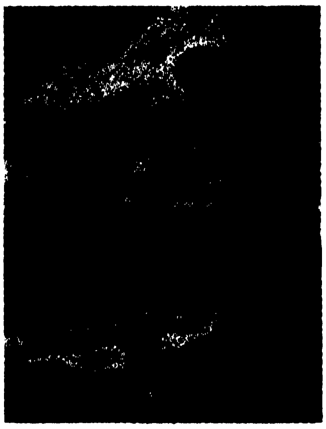
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of October, 1892)

TELEPHONE—"The perfection of the science of long distance telephony has been going on for the past five or six years, until an epoch of much interest has finally been reached; that is the perfect transmission of articulate speech for a distance of one thousand miles and over. . . An important element in the success of long distance telephony is the improved battery now used for energizing the transmitter, which has the merit of maintaining a nearly uniform electro-motive force of high tension for an extensive period of time. . . The long distance transmitter also has been improved by using in it one uniform size of carbon granules, obtained by passing them through a sieve of a certain mesh."

BALLOONS—"In Europe, the principal governments now have ballooning corps attached to their armies, by means of which observing balloons may be readily transported and quickly inflated on the field. . . The German military balloon car is suspended from a trapeze, which lessens its oscillation . . The rope-winding mechanism, by which the height of the balloon is regulated, is arranged upon a strong wagon, and is operated by a steam engine, the whole presenting the general appearance of a steam fire engine. The hydrogen gas for inflating the balloon is carried to the field in highly condensed form in separate steel cylinders. In operation a central steel cylinder, of larger size than the others, is laid upon the ground and the smaller cylinders are then attached to its sides. A flexible pipe at one end of the large cylinder conducts the gas to the balloon."



CHOLERA—"In Asia and Russia the cholera has carried off many thousands of poor people, chiefly by reason of the filth in which the victims lived and the lack of proper medical treatment. In Europe the disease made no alarming progress, except in Hamburg, where it was brought from Russia, and, owing to the dirty condition of the town and the supineness of the authorities in adopting proper sanitary measures, the advance of the disease became rapid and ominous . . Hamburg is notorious for its crowded and filthy tenements . It is a peculiarity of this disease that its spread may be readily checked and controlled by the early adoption of intelligent precautionary means and regulations."

BAKU—"The supply of crude petroleum at Baku, on the Caspian Sea, is apparently inexhaustible, but until within the last ten years the town has been practically isolated from the rest of Europe, a long and troublesome journey being required to get to it. This has now been changed, and Baku at present has steam communication with all parts of Europe. The Nobel brothers have borne a prominent part in developing the petroleum industry here, laying the first pipe lines, employing tank steamers for conveying the product, and taking the lead in employing petroleum as fuel for the steamers. There is now not a vessel on the Caspian using wood or coal, liquid fuel being employed exclusively."

AMPHIBIAN—"Seldom have land and water been laid under contribution by a single mechanical device. It remained for the genius of a citizen of Chicago to devise a machine for both use and pleasure, which should enable his fellows to traverse with great speed either land or water, proceeding readily from one on to the other. . . It consists of twin boats rigidly connected and a tricycle connected to said boats so ingeniously aranged that the machine is propelled and steered by the same mechanism. This machine has the most perfect stability in either element"

TRACTOR—"Peter Chalmers, a farmer, is a genius in his line When anything new comes out he studies to see whether it cannot be adapted to use on his farm. . . All the plowing done on Chalmers' big ranch is done with a traction engine. . . Now the farmer is hauling wheat to town with his engine He brought a load in recently and stored it at the Stockton Warehouse There were nine wagons in the train, and each carried sixty-eight sacks of grain. Each sack weighs, on an average, 137 pounds, so each wagon load was 9,316 pounds, and the aggregate of all the wagon loads 83,844, or nearly forty-two tons. . The engine can haul the train at the rate of four miles and a half an hour, but to prevent jolting the speed is regulated to about three miles an hour."

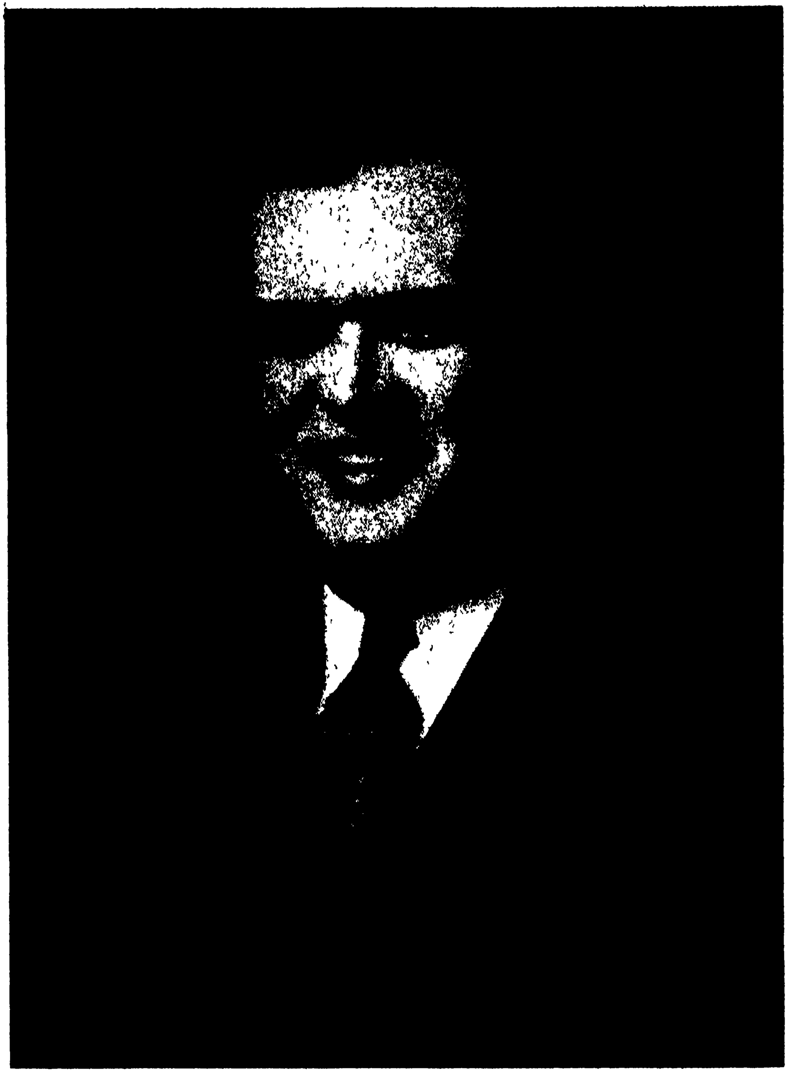
EDISON—"The village of Ogden, N. J., now known as Edison, has been built up within the last two years. . When Mr. Edison invented the magnetic ore separator, he organized the New Jersey and Pennsylvania Concentration Company, and a plant was established at Ogden, the name of which was then changed to Edison. The ore as taken from the mine is run through enormous crushing machines, and then passed through the Edison separator, where powerful magnets attract all the metal, which is afterward run into pigs"

SOUND STEAMER—"The new twin-screw steamboat Richard Peck, built by the Narlan & Hollingsworth Company, at Wilmington, Del., for the New Haven steamboat line, made 20¼ miles an hour on her trial trip recently. The boat is 316 feet long over all, 48 feet beam over guards, and has a depth of hold of 18½ feet. Her horse power is 4,000 and her gross tonnage is 2,906."

FAN—"A fan attachment for rocking chairs is to be applied to a platform rocker, and, as one rocks backward and forward, a continuous rotary movement will be imparted to a fan held above the occupant of the chair, affording a constant and refreshing current of air."

COAST-WISE—"The proposal to establish an inland waterway between the Atlantic coast cities is once more under consideration. In its amplest form such a route would extend from Massachusetts Bay to Texas, making use of sounds and bayous as well as of existing canals as far as possible. This form of the enterprise contemplates the cutting of three new canals, through Cape Cod, Maryland, and the Florida peninsula; and as its expense would mount into the hundred millions, it is not likely to find favor at present."

Personalities in Industry



DR. CHARLES B. JOLLIFFE

AWARE that this is a "radio war" as much as it is a clash of mechanized forces, Dr. Charles Byron Jolliffe, Assistant to the President, Radio Corporation of America, and Chief Engineer, RCA Laboratories, is giving every ounce of his energy to furthering the all-important role of radio in supplying the "nervous system" for the nation's war machine.

"Radio provides the long-range eyes and ears of field troops, tanks, airplanes, and warships," says Dr. Jolliffe. "Therefore, it is up to the American radio industry to see to it that our armed forces are equipped with radio 'eyes and ears' that will out-perform anything that the Axis powers may devise."

Holding down a multi-phased job of liaison, technical counsel, and coordination between his company, all the activities of which are closely geared to the war effort, and various Government officials and agencies is Dr. Jolliffe's personal way of outdoing the enemy.

As Chief Engineer of RCA Laboratories—a post that includes direction of the RCA Frequency Bureau—Dr. Jolliffe directs and coordinates the broad engineering policies of RCA, represents the corporation, and directs its representation before public and governmental bodies.

As vice-chairman of Division C of the National Defense Research Committee, Office of Scientific Research and Development; as secretary of the Industry Advisory Committee of the Defense Communications Board; and as a member of the Engineers Defense Board, he contributes liberally of his broad knowledge of radio practices and potentialities.

In fact, Dr. Jolliffe is equipped by education, training, and experience as few other men are for his multiplicity of responsibilities. A big man physically, he has a big capacity for labor Ask him how he is able to accomplish as much as he does, and he replies: "I just go ahead and do the job." There is more to it than that, however. Some of his associates say that he has been known to work twenty-four hours at a stretch. This doesn't mean that he works that way as a rule, but it does signify his willingness to keep going until the job at hand is completed.

Born in Mannington, West Virginia, November 13, 1894, he developed an early interest in physics and chemistry, concentrating on these two subjects at West Virginia University, from where he was graduated, with a bachelor's degree in science, in 1915.

During the years from 1915 to 1922, he continued his studies while serving as an instructor of physics at West Virginia University and Cornell University. He won his M.S. from West Virginia in 1920 and his Ph.D. from Cornell in 1922. Also in this period, from March, 1918, to February, 1919, he was attached to the United States Army Air Service, Science and Research Division. In May of this year, Dr. Jolliffe was awarded the honorary degree of LL.D by West Virginia University.

From 1922 to 1930, Dr. Jolliffe was a physicist in the Radio Section of the U. S. Bureau of Standards, Washington, D. C., rising to the position of Assistant Chief of the Section. His research on radio-wave propagation and the development and maintenance of frequency standards resulted in several scientific publications and helped to form the basis for regulations which brought order out of the chaos into which broadcasting had fallen.

In March, 1930, Dr. Jolliffe was appointed Chief Engineer of the Federal Radio Commission, continuing in this capacity when the organization was changed to the Federal Communications Commission in July, 1934. He resigned from the FCC in November, 1935, to become Engineer-in-Charge of the RCA Frequency Bureau. He was appointed Chief Engineer, RCA Laboratories, in March, 1941, and Assistant to the President, RCA, in January, 1942.

98TH YEAR SCIENTIFIC AMERICAN OCTOBER 1942

SLENDER, SPEEDY, SCRAPPY

Destroyers Are Highly Important Factors in Naval Warfare

WALTON L. ROBINSON

Of the various types of combatant ships in the world's navies the destroyer is, without doubt, the most versatile and hardest fighting. Armed with torpedoes, guns, and depth charges, she is a deadly menace to the enemy on, above, and beneath the sea. Long, slender, and speedy, she possesses great maneuverability and hence offers an exceptionally difficult target to hostile warships, aircraft, or submarines. But once hit by a torpedo, bomb, or heavy shell, the destroyer is in a serious plight, for her construction is very fragile and not intended to withstand any really hard blows The experience last year, however, of the U.S.S. *Kearney*, one of our latest destroyers, is an excellent example of the severe punishment one of these boats can sometimes receive and yet reach port under her own power.

America and Britain urgently need more and more destroyers and other anti-submarine craft to combat the grave Axis U-boat threat in the North Atlantic. We must have as many destroyers and sub-chasers as possible in order to smash the enemy's U-boats faster than he can turn out new ones. Destroyers are, everything considered, the best all-'round anti-submarine type yet developed, especially for deep-sea convoy work. These remarkable boats can also perform several other important missions, among them torpedo attacks on hostile battleships, aircraft carriers, and cruisers in a major engagement. Their various functions were fully covered in an article which appeared in Scientific American for February, 1942.

The United States Navy is exceptionally well provided with destroyers. Our shipyards, furthermore, are turning out new ones at an astonishing rate. As of December 1, 1941—just a week before Pearl Harbor—we had 171 destroyers in commission and 191 others under construction or on order. Britain possessed some 230 in service and Japan about 125, of which at least 20 were small units (torpedo boats) of only 500 to 800 tons.

● Fourth analytical article of a series on ships of the United States Navy. The fifth, on submarines, is scheduled for publication in November. Previous articles were on battleships, carriers, and cruisers, published in May, August, and September of this year. —The Editor. ●

Our destroyer strength included 72 boats of World War I vintage With the exception of the 920-ton *Allen*, all of these old destroyers were of the well-known "flush deck" type. The *Allen*, completed in 1917, was of still earlier design and the sole survivor of her class. Her armament consists of four 4-inch, 50-caliber guns, two 3-inch, 23-caliber anti-aircraft weapons, and twelve torpedo tubes firing "tin fish" of 21-inch diameter. Designed speed is 29.5 knots, obtained by 17,000-horsepower geared turbine engines driving two propellers Although having four funnels like the "flush deckers," the *Allen* can easily be distinguished from them by her raised or broken forecastle. Despite her 25 years, of which 18 were spent in reserve, she can still make things quite uncomfortable for Axis undersea raiders.

The "flush deckers," commissioned between 1918 and 1922, were the survivors of a class which at one time consisted of 273 units. Eleven had been lost by shipwreck or other accident, 93 stricken from the list and sold or scrapped, 50 traded to Britain for base rights, and one, the *Reuben James*, sunk by a Nazi U-boat (October 31, 1941). The remaining 46, their torpedo tubes and some of their guns removed, were serving in various auxiliary capacities: 16 as fast minesweepers, 14 as seaplane tenders, 8 as light minelayers, 6 as fast transports for Marine landing forces, and 2 as experimental vessels.

The 71 units still rated as destroyers ranged in displacement from 1060 to 1193 tons and were armed or had originally been armed with twelve 21-inch torpedo tubes in triple deck mountings, two on either beam. All of them carried four 4-inch guns except the *Brooks*, *Fox*, *Gilmer*, *Hatfield*, and *Kane*, which had four 5-inch, 51-caliber weapons

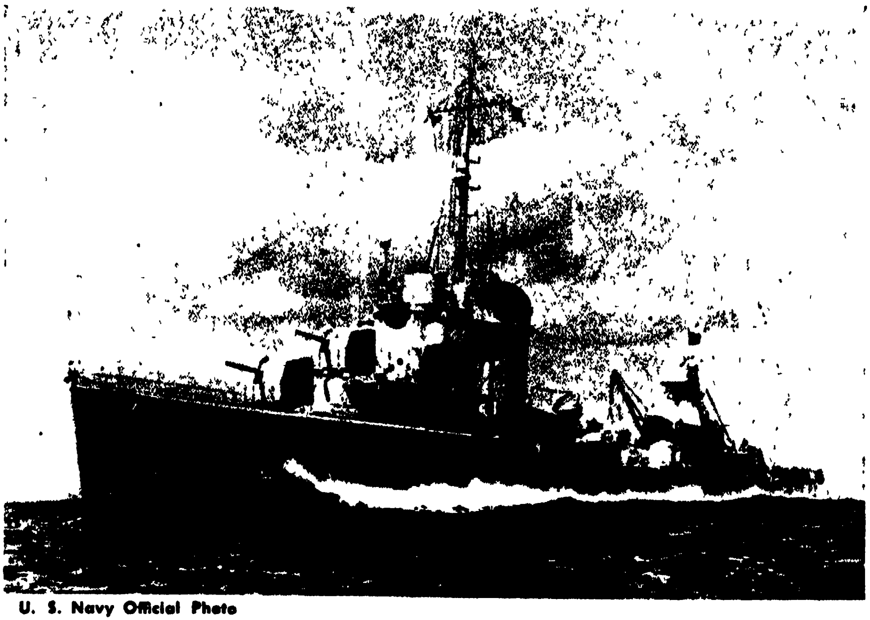
All of these destroyers are now very nearly worn out, but, like the *Allen*, can still engage effectively in anti-submarine work. Most of them are believed to be on escort and patrol duty in the Atlantic. Others, presumably, were with the Asiatic Fleet when hostilities with Japan commenced They acquitted themselves well, particularly in night torpedo attacks on heavily escorted Jap convoys in the Macassar, Lombak, and Bali Straits, and in the ill-starred cruiser action of the Java Sea. Eight of them were lost during the first six months of war: the *Pope*, *Stewart*, *Pillsbury*, *Edsall*, and *Peary* in the Far East and the *Jacob Jones*, *Truxton*, and *Sturtevant* in the Atlantic.

A decade passed between the commissioning of the last of the "flush deckers" and the laying down of the U.S.S. *Farragut*—the first of our rapidly expanding force of modern destroyers. Work on the *Farragut* was begun in September, 1932, by the Bethlehem Steel Company, Quincy, Massachusetts. Seven sister boats were laid down during the next year and a half. All eight units were completed in 1934-35 at an average cost of over

$3,500,000. Their displacements range from the 1345 tons of the *Dewey* to the 1410 tons of the *Worden*. They mount five 5-inch, 38-caliber "dual purpose" guns, four or more 1.1-inch anti-aircraft machine guns, and eight 21-inch torpedo tubes in quadruple mounts along the center-line. Geared turbine engines, developing 42,800 horsepower and driving two screws, give the *Farraguts* a designed speed of 36.5 knots. Trial speeds in excess of 41 knots have been reported. Four Yarrow high-pressure boilers provide steam for the turbines. Oil fuel capacity is 400 tons, sufficient for a cruising range of well over 6000 miles.

The *Farraguts* differ widely in appearance from the "flush deckers" and represent a considerable improvement over them. They have a raised forecastle and only two funnels instead of the flush deck and four funnels of the older boats. They are faster and better steamers, have a much steadier gun platform, and are not so wet forward in heavy seas. These superior nautical qualities obtain in all of our modern destroyers.

In 1933-34 twenty-four destroyers were laid down. Eight of them belonged to the *Porter* class and the remainder to the *Mahan* class. The former were large, powerfully armed boats of an entirely new design, intended to operate as squadron leaders. They displace 1805 tons and mount eight 5-inch guns, at least ten smaller anti-aircraft weapons, and eight 21-inch torpedo tubes. The 5-inch guns are paired in enclosed shields, superimposed, two forward and two aft, giving these boats an appearance very similar to a light cruiser's. This resemblance is increased by the heavy tripod masts with their searchlight platforms. The torpedo tubes are grouped in fours on high revolving mounts, one between the two funnels and one between the second funnel and the mainmast. Designed speed is 37 knots, obtained by 50,000-horsepower engines. On trials 39 knots were attained without difficulty. About 600 tons of fuel oil can be carried. Each boat cost about $4,000,000 to build.


U. S. Navy Official Photo

USS Anderson, Sims class, combines many successful features

U. S. Navy Official Photo

USS Ellyson carries 5-inch guns

The 16 units of the *Mahan* class, all completed in 1936-37, were an enlargement of the *Farragut* design. Two of them, the *Cassin* and *Downes*, sank under Jap air bombs at Pearl Harbor, while a third, the *Shaw*, had her whole forepart demolished. With a temporary bow fitted, however, she reached a West Coast port for permanent repairs.

On displacements ranging from 1450 to 1500 tons, the *Mahans*, as compared with the *Farraguts*, carry four additional torpedo tubes and about 100 tons more fuel oil. The foremost set of tubes is on a high center-line mount between the funnels, while the remaining two sets, one on either beam, are mounted on the deck and abaft the second funnel. Originally these boats could be distinguished from the *Farraguts* by their tripod foremast, light mainmast stepped right behind the second stack, and No. 3 gun (5-inch) on the after shelter deck (instead of abaft the second funnel, as in the *Farraguts*) Recently, however, pole rig has replaced the tripods, and mainmasts have been removed from some units.

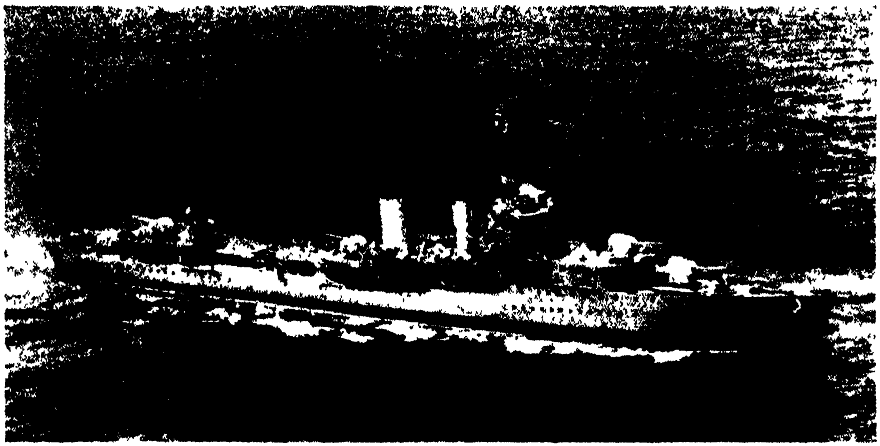
Fourteen destroyers, 10 of the *Craven* class, two of the *Dunlap* class, and two of the *Somers* class, were laid down in 1935. The *Cravens* are 1500-tonners with four 5-inch guns and sixteen torpedo tubes—the heaviest torpedo armament ever fitted in a destroyer and equalled only in the 7500-ton British cruisers *Emerald* and *Enterprise*. Their two forward 5-inch guns are mounted singly in enclosed shields, while their torpedo tubes are in quadruple mounts, two on either side of the deck. Designed horsepower and speed are the same as in the *Mahan* and *Farragut*, but fuel oil capacity has been increased to 600 tons, giving a range of more than 8000 miles at 15 knots. The *Cravens* can readily be distinguished from our earlier destroyers by their single, flat-sided funnel. In 1936-37 work on 12 additional boats, differing slightly in appearance and known as the *McCall* class, was commenced. In them the freeboard amidships, between the forecastle and the foremost sets of torpedo tubes, was raised several feet in order to keep out heavy seas. One unit of the group, the *Benham*, considerably exceeded 40 knots on her trial runs, thereby smashing all speed records for American destroyers.

The *Dunlap* and *Fanning*, commissioned in 1937, are generally similar to the *Mahans*, differing from them only in having their forward 5-inch gun in enclosed shields.

The 1850-ton *Somers* and *Warring-*

ton and three sister boats laid down in 1936 (*Sampson, Davis,* and *Jouett*) are logical developments of the *Porter* design. They have an extra set of torpedo tubes, slightly increased horsepower (52,000), a single funnel, and greatly reduced rig. Their 12 torpedo tubes, mounted quadruply on the center-line, enable them to fire the world's heaviest torpedo salvo. A pole foremast replaces the tripod of the *Porter,* while the mainmast is a mere stump, intended only as a flag-staff.

Twelve 1570-ton *Sims* class boats, combining the most successful features of the *Dunlap* and *McCall* designs, were begun in 1937-38. Their armament was similar to the *Dunlap's,* while in general appearance they closely resembled the *McCall.* Under service conditions, however, serious defects in stability developed. These were remedied in the earlier units by adding 60 or more tons of steel to the keel as ballast, while in later boats weight was saved by reducing the thickness of the plating for decks and superstructure. As finally completed, therefore, the *Sims* class actually displaced from 1640 to 1670 tons and carried five 5-inch guns and eight or 12 torpedo tubes. Enclosed shields were provided for guns Numbers 1, 2, and 5, and light armor protected the bridges and control positions. Features of the design were the rounded lines of the forecastle and forward superstructure, which gave these boats a distinctly streamlined appearance They were refitted last year and given additional anti-aircraft guns, and torpedo armament was reduced to eight tubes.



U. S. Navy Official Photo

USS Dewey, Farragut class, has reported speed of 41 knots

In 1938-39 twenty-four *Benson* class destroyers, two-funneled modifications of the *Sims* design, were laid down. They were the last of 97 destroyers built under the qualitative limitations of the 1936 London Naval Treaty. All entered service in 1940-41, the *Ingraham,* last of the group, being commissioned in July, 1941. On a displacement of at least 1630 tons they carried five 5-inch guns (now being reduced to four) and eight or 10 torpedo tubes.

U S. Navy Official Photo

USS Clark, Porter class: Powerfully armed, entirely new design

The 1940 program authorized the construction of 38 new destroyers. This was soon followed by a special emergency program providing for 155 additional boats. These 193 destroyers will be of three distinct types. The *Bristol* class, comprising 78 units, are 1700-ton improvements over the *Benson* design. Two of them, the *Bristol* and *Ellyson,* entered service just before we were attacked by Japan. Two others, *Emmons* and *Hambleton,* were commissioned soon afterwards. The *Bristols* carry four 5-inch guns and most of them have a torpedo armament of ten tubes, quintuply mounted.

Two 2100-ton destroyers, *Percival* and *Watson,* are listed as belonging to a "Special Type," concerning which all details are restricted. The remaining 115 new destroyers will be of the *Fletcher* class, 2100-tonners designed as "replies" to Japan's 2000-ton *Kagero* class boats, which mount six 5-inch guns and, according to some reports, eight tubes for discharging huge 24.5-inch torpedoes. No particulars concerning the *Fletchers* have been released.

The commissioning of these new destroyers should profoundly influence the course of the war at sea. Stronger anti-submarine and anti-aircraft protection can then be given to all of our convoys in the Atlantic and Pacific, while the U-boat threat off our East Coast can be greatly reduced if not entirely eliminated. The Navy Department is taking no chances, however, and since Pearl Harbor has asked for several hundred new destroyers and other escort types.

U. S. Navy Official Photo

USS Mayrant, McCall class, has higher freeboard amidships

Day After Tomorrow

How the War-Time Workings of a Variety of Industries Will be Reflected in Peace-Time Operations

A. P. PECK

(In Two Parts—Part One)

• SITTING at an editor's desk during such times as these gives one a curious sense of detached attachment with the world of science and industry. The editor is part of it all, yet, so to speak, is on "detached service." Across his desk pour reports from all fronts—military, industrial, governmental, personnel. From these reports are sifted material for publication, leads for articles, waste paper for reclamation, all gradually working toward the finished magazine that you see each month. One of the leads so sifted resulted in the beginnings of an industrial survey upon which is based the accompanying article, compiled after personal interviews with leading industrialists, extensive correspondence, and mulling over of voluminous published material.

The present article, therefore, may be considered as a compendium of several minds, brought together and woven into one running story. All that the story tells, however, is not in the written word. Between the lines there is to be found a grim determination on the part of American industry that, come what may, the American way of free enterprise will not be relinquished without a fight, that industry will, after the war is won, demonstrate once more that it is capable of giving to the people of this nation and of the world those benefits that can be provided only under the proved system of democracy.—*The Author.* •

To what extent are research, development, and invention, as prompted by war-time production, being correlated with plans for civilian production in post-war days? That question expresses the essence of SCIENTIFIC AMERICAN's industrial survey; the answers to it and other queries which would naturally arise in any ensuing discussion form the basis of the present article.

But before reporting the results of this survey in detail, it is desirable that certain things regarding it be fully understood First, the survey itself is based entirely on the premise that the United Nations will win the war. At the time of writing and from this point of view there is no assurance that this will be the case, although an inborn faith in the ability of the United States as a nation to carry through with a given project, no matter how long it may take to complete, makes it almost impossible to think otherwise. Thus, while some may place the stamp of wishful thinking upon such a premise, the assumption that we will win the war—and then will have to win the peace—must be kept in mind when reading the following paragraphs.

Secondly, there may arise the argument that any thinking toward post-war production or post-war activities of any kind will of necessity detract just that much from the more important work of the moment—winning the war. This is necessarily a fallacious argument, since it must be based on the assumption that the human mind is a machine that can be directed at all times along a set path. Where is the business executive, the engineer, the production man, who. face to face with the shaving mirror. under the morning shower, dozing off to sleep at night, does not frequently find his mind toying more or less casually with some problem far afield from his immediate occupation? What is more natural, then. that these same men, even though engrossed with problems of war-time production, should visualize the effect that their present work will have on the future in the bright day after tomorrow when the war is over and the problems of peace-time operations once more arise?

That such visualizations will benefit the entire human race is obvious. That they can interfere in the smallest amount with the war effort is a thought that has no real basis in fact. That they can even serve to stimulate present production is an important possibility, acting, as they so frequently can, as a spur to mental and physical activity and as an incentive to get the present job done so that the war can be won and we can get back to more normal work.

Yet, despite all the things that are being done and have been accomplished for post war operations, there are still those who feel that such planning is useless. True, the planning is all subject to change without notice and what may seem perfection today may be in the discard by tomorrow. Nevertheless, any planning, so long as it be based on sound reasoning, is better than none at all There are many who will not agree with this. For example, there is the top executive of a huge plumbing manufacturing organization who, when asked the question in the first sentence of this article, replied: "Not at all" Then he spent an hour telling of his disapproval of many different governmental plans for many things At least the government planning was an attempt to step forward and must be accepted as being more desirable that a "Not at all" attitude.

Mayor Fiorello H La Guardia, of New York City, in a quoted statement, recently made himself representative of the confusion that exists in many minds regarding this matter of preparation for day after tomorrow. "Let's win this war first and discuss the after-war period later," said Mayor La Guardia. Later, but on the same occasion, he suggested that the government have a vast public works program "ready to roll into operation to prevent . . serious dislocation after the war" How this program will grow to a point where it can be put into operation without planning is something that the Mayor did not explain.

There are, however, many outstanding industrialists who have given serious thought to the future, familiar as they are with the necessity of careful planning of all steps that involve the operation of a successful business. These same men know, also, that all plans are necessarily impermanent, that they must be laid with an eye to change, that the lessons learned from day to day may soon outmode operations that today seem basic in nature. Yet, in the light of such knowledge they are willing to voice opinions regarding the future, to place at the disposal of others their restrained optimism, their "know-how," gleaned through years of hard-won experience

It should be noted that the basic question of this industrial survey limits it severely—and purposely—to technological developments of today which will affect our post-war world No attempt has been made to assay or evaluate the psychological effect of World War II on the worker, to enquire into the sociological problems of the future, or to become concerned with any views of the future other than those which can be based on the practical industrial developments of the moment. Interesting though these other aspects may be, they have been purposely avoided and left to the tender mercies of other researchers. They, of course, will have their place in the future, but since experience has shown the vast importance of technology in the development of our industrial civilization, it seems only right that at this critical moment in history due attention should be paid to it and to the part which it will play in the coming days of peace.

The first organization to be approached in the development of this survey was Westinghouse Electric and Manufacturing Company. This company, like many others, is so far converted to war-time production that its out-put for civilian consumption is now an almost non-existent part of operations. Yet "planning for post-war operations is very definitely a part of the Westinghouse program today," said G. H. Bucher, President of Westinghouse. "However, because the future is still obscured by clouds of war, the planning must necessarily be subject to workable flexibility. Executive meetings, held every two weeks, almost invariably involve discussions of such plans. Frequently, these plans take immediate form in a step forward in our war-time production processes; sometimes they must be shelved for the duration. And when a step is taken it may not necessarily appear to be in the direction of peace-time operations, yet it is invariably along the industrial path to future developments.

© Bachrach

G. H. Bucher, Westinghouse: "Our development and research programs are larger than ever before . . ."

"Probably the best way to summarize our present position as regards 'Day After Tomorrow' is to say that our development and research programs are larger than ever before. This does not involve our consumer-goods production program which, of course, has been severely curtailed in many fields to meet the increasing demands for military production.

"Because of the need for military secrecy about many of the activities of Westinghouse, it is virtually impossible to give exact statements on correlation of war-time production with possible civilian production in post-war days. We are learning many things in a wide variety of fields, however, and every assurance can be given that lessons from our war-time activities will have many applications later on."

Westinghouse is known to be engaged in the manufacture of many kinds of war apparatus that will possibly lead to new developments for peace For example, some time ago when Army officials wanted to find means of improving the gunners' marksmanship in tanks, they came to Westinghouse with the problem. When a tank is speeding over rough ground, the gunner's task of hitting a given target may be likened to an attempt to thread a needle while galloping on horseback. Westinghouse research engineers produced fire-control equipment that resulted in considerable improvement. This fire-control equipment probably can be adapted to post-war uses, with great advantages over the peace-time mechanism that gave it birth—advantages that might never have been realized but for the impetus of war-time demands.

Another war-time development that may have wide uses in peace-time is a radio panel consisting of a layer of spun-glass cloth sandwiched between layers of fireproof, strong plastic Westinghouse engineers developed the combination to resist the stresses that are set up on board a battleship when a broadside is fired. Under these conditions, there is a sudden compression of air in below-deck compartments—often sufficiently severe to shatter the brittle panels ordinarily used in radio and control instruments.

Use of radio communication between ships in war-time convoys is restricted, lest the signals give information to the enemy. Westinghouse illumination engineers have designed a lamp by which code signals can be transmitted in a horizontal, narrow beam not visible from altitudes that enemy aircraft must fly.

In much of the war production of Westinghouse, of which the preceding paragraphs give but a sketchy idea, engineers have had to call on all of their skill and ingenuity, particularly in making up for the loss of materials on the priority list. Substitutes have been devised for long-accepted materials and, often, substitutes have had to be devised for substitutes. In practically every case, however, the substitutes have been so efficient that in only a few applications has performance or quality suffered; frequently the changes have been for the better.

An important part of the equipment which the company has installed for war production will be available, with little or no change, for post-war operations, Mr. Bucher believes.

"An example of this is found in the manufacture of ship propulsion motors," he explained. "If the end of the war ends the demand for these motors, the same production facilities can be turned over to the manufacture of generators for peace-time use.

"In spite of all the extra engineering effort going into our work to meet war requirements, some improvement is necessarily continuing in transformers, generators, motors, and lighting equipment, as well as in household appliances and the multitude of other things, counting all the variations of each, that add up to the grand total of over 100,000 products made by Westinghouse. We feel that all of this gives assurance that, after the present world debacle is over, living standards can again resume their upward climb."

Far different in scope from the electrical industry are those organizations devoted to the production of metals. Some of the steel producers did not feel that they could co-operate in this survey, apparently because their operations are so basic in nature that war production means simply an all-around speed-up rather than any change in principles The aluminum industry, however, represented in this case by the Aluminum Company of America,

Dr. Francis C. Frary, Aluminum Company: "One of the most fertile fields for aluminum in the future" is in the manufacture of textiles

had much to say about the present and future.

"Right now, of course," stated Dr. Francis C. Frary, Director of Research at the Aluminum Research Laboratories, "we are confining all our efforts to the production of aluminum for military purposes. There are items, however, which were just barely under way at the time of Pearl Harbor which had to be shelved for the duration, despite their tremendous possibilities. These are the items which should be stressed, principally because they have already been proved and are not merely idle fancies that come under the head of wishful thinking.

"Wide aluminum applications in architecture are about 12 years old, yet this field has barely been touched. There were a number of dramatic installations, such as the spandrels on a number of modern skyscrapers, the use of aluminum in decorative statuary, and in molding and trim, but, on the whole, there are many applications of aluminum in architecture which need developing. One of these is the aluminum window frame for residential construction. We feel that here aluminum has a very bright future, because these frames are efficient, permanent, easy to handle, and present no problems of maintenance. The frames which have been installed in large skyscrapers in the past 12 years have given no trouble, and we feel that the same condition will prevail when aluminum window frames are adapted for home construction.

"The first aluminum streamlined train made its debut in February, 1934," continued Dr. Frary. "Since that time, about a dozen such trains have been built and are now in service. Their performance made a tremendous impression upon railroad officials, and they will no doubt be the forerunners of a great number of other aluminum trains. In addition, more aluminum will be used on freight equipment. Some very thorough tests were made with hopper cars for coal and sulfur transportation. Sulfur attacks steel rather rapidly, but has no effect on aluminum. All coal contains a certain amount of sulfur, and this chemical in the past has been a problem to railroad officials. The elimination of this problem by the use of aluminum-bodied hopper cars with aluminum facings may well be considered at the time when aluminum will be again available for civilian needs."

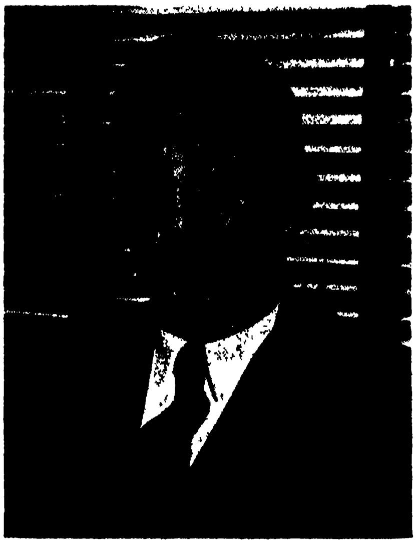
The sinking of hundreds of merchant ships during the past two and a half years means that there is bound to be great and continuing activity in marine construction at the conclusion of the war. The world is and will be greatly in need of ships to carry on its commerce, and the number of these ships must be adequate to take care of world trade. Aluminum long ago had been found to be a desirable metal in marine construction. The use of aluminum for entire superstructures, boats, davits, fittings, bulkheads for passenger quarters, and for numerous other applications allows a redistribution of weight in such a manner that the ship will function as a more efficient unit. It will either be lightened to such an extent that smaller engines will be needed to propel the boat at a given speed, thus saving fuel costs; or, with the same type of engines as formerly used, the boat, being so much lighter, can be propelled faster and reach its destination sooner, thus saving time.

Life boats also hold interest as a future development. As far as is known, there are about 70 all-aluminum life boats in service at the present time. A number of these are on European ships; the United Fruit Company has had a number of aluminum life boats in service for several years and is quite enthusiastic about them. The *Nieuw Amsterdam*, flagship of the Holland-America Line placed in service about 1937, had 22 aluminum life boats. Aluminum life boats are not only free from maintenance troubles, but they also serve to lessen the weight of the ship at a point where weight is not desirable; namely, near the top deck. The lesser weight, therefore, increases the stability of the ship, and is more practical, according to Dr. Frary.

"Aluminum has been used in the textile field for some time," continued Dr Frary, "but its applications there can be widely increased. In our opinion it is one of the most fertile fields for aluminum in the immediate future, particularly since rayon and nylon are enjoying an ever-increasing popularity. Aluminum is widely used in the manufacture of these textiles."

The art of brazing aluminum has been developed to a commercial degree within the past year or so. Unfortunately, activities in aluminum brazing have had to be heavily curtailed because of the war effort, but this will no doubt be a method of joining aluminum to be seriously considered in the future.

Mr. John O. Chesley, Manager of the Development Division of the Aluminum Company of America, had this to say: "The aluminum beer barrel had a very interesting history, and we feel confident that it will be in great demand when aluminum is again available for civilian purposes. The beer barrel got under way very slowly at first, but it was found to be so excellent a package for beer that brewers had begun to buy it in large quantities when the metal was withdrawn from the civilian market. A typical aluminum half-barrel weighs only 18 pounds, whereas a wooden barrel of the same dimension weighs 65 pounds. The aluminum barrel does not have to be pitched, since aluminum does not affect the taste, odor, color, clarity, or limpidity of beer. There are no maintenance problems to speak of with the aluminum barrel. All these advantages combined to make this barrel a very desirable commodity.



John O. Chesley, Aluminum: "Just to show that we are trying not to miss any bets in the world to come . . ."

"Just to show that we are trying not to miss any bets in the aluminum world to come, we might cite one commodity which was ready for marketing when the war broke out and priorities put a stop to this type of product. That is the aluminum plate used by artists for making etchings and dry-points. Copper had been the traditional medium for more than 400 years, but copper had certain disadvantages which have been overcome by a special aluminum plate. In the case of copper, an artist could only make about 75 good prints from an etched plate before the plate would begin to break down. He could only make about 15 good prints from a dry-point. In aluminum, an edition of 250 prints is generally possible, and in many cases, the edition far exceeds this figure. This holds for both etchings and dry-points on aluminum. The metal, furthermore, is light in color and, therefore, easy on the eyes. It has only one disadvantage: once a line is cut, this line cannot be eradicated by the methods used with copper. The line is there to stay and cannot be changed."

Add to all this the new know-how in aluminum manufacture and fabrication that is being acquired, the development of centrifugal casting of the light metal, the possibilities of aluminization of steel to replace tin plate, and so on, and it becomes obvious that the civilian of the future will think of more than pots and pans when aluminum is mentioned.

Welding of metals of all kinds has come so rapidly to the fore in so many war-production operations that Mr. James F. Lincoln, President of the Lincoln Electric Company, was consulted regarding his views of the future. "The problems which I believe we are going to meet after this war is over," said Mr. Lincoln, "are two-fold:

"First of all, there will be great unemployment because even if the call for goods after the war is so great to keep all men employed, the reshuffling of these men from the war industries to peace-time work will take some time. We are, therefore, planning on cushioning this shock to these men by present-day savings.

"The second thing that will occur is that competition will have changed to a very great extent due to the existence of a great many government financed organizations which will have much less overhead than those who have financed their own expansions.

"Because of those two things it is our policy," continued Mr. Lincoln, "to now develop the new machinery or present-day production methods which will be more efficient and which can be used in the post-war period, and to get now the higher efficiencies from this machinery and, therefore, the lower cost. It is our policy also to develop the end product to the maximum degree possible under present conditions.

"We are in the very fortunate situation of having a product which now is the same as it was before; the war effort is not changing the character of our product, so that the development of the product and the manufacture of it is continuing for the war effort just as it will for the peace-time effort after the war is over.

"Therefore, we are also bending our energies toward a reduction in cost of the application of the process, and to the elimination of a great many of the abuses which now exist because of ignorance in the field about the application of the process, so that the actual cost of doing the work will be cut to a minimum.

James F. Lincoln, Lincoln Electric Company: "There is nothing that can keep us from hoping, which is also part of our post-war program"

"Of course," concluded Mr. Lincoln, "there are a great many unknown features facing us. For instance, there is no way of knowing what kind of government we will have when this is over. It is rather obvious from previous history that it will be totalitarian. No bankrupt nation ever escaped totalitarianism. Under those conditions perhaps all of our planning will go for naught because we will be told by bureaucrats what to do and how to do it, but there is nothing that can keep us from still hoping, which is also part of our post-war program."

Despite the somewhat pessimistic note on which Mr. Lincoln ends his contribution to this survey, it is obvious from even the few views expressed here that American industry is fully alive to the responsibilities which it faces in the day after tomorrow. In our next issue will be continued our report on the unearthing of these encouraging views.

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CORK SUBSTITUTE

Found in Product of Sugar Cane

Sugar cane from Louisiana has been called upon to take the place of cork from war-encircled Spain to help protect the nation's supply of perishable foodstuffs. From the fibers remaining after the sugar juices have been squeezed from the cane stalks, a new kind of cold-storage insulation has been developed by The Celotex Corporation. Its ability to keep out heat is said to be equal to corkboard's. It is cheaper, stronger, and the supply of raw material far exceeds all possible needs of the United States and its allies.

More than a year ago, as the war gradually strangled the flow of cork bark from Spain's trees to industry in the United States, research men began seeking a satisfactory substitute for corkboard insulation. In the Celotex company's big plant and research laboratories at Marrero, Louisiana, across the Mississippi from New Orleans, they developed a product with all of cork's useful insulating qualities.

To match cork's ability to slow down the passage of heat, the research men mixed the cane fibers in selected lengths and thicknesses, then wove and felted them into half-inch insulating boards of a low density.

To equal cork's resistance to moisture, the individual fibers, before being felted into boards, are sterilized, waterproofed, and then protected from dry rot and fungus growths by the patented Ferox process.

To provide further resistance against moisture, the half-inch boards are laminated together with weather-resistant special asphalts between layers. An additional coating of asphalt is then applied to the outer surfaces. Thus, a two-inch thickness of insulation has five moisture-resistant asphalt membranes, one on each outer surface and three between the boards.

WAR PLANTS

Being Built of Wood and Concrete

Two new buildings for the manufacture of airplane engines under mass-production conditions have recently been announced as being designed to make use of readily available material and to conserve steel for other war purposes.

One of these new plants is being erected "somewhere in Michigan," the other "somewhere in New Jersey." The first, being built by Continental Aviation & Engineering Corporation and designed by the Russell Engineering Corporation, is being built of wood and other substitutes for critical materials throughout. Exterior walls and piers will be of brick, and interior columns, trusses, and sash will be of wood. Mass concrete footings without reinforcement will be used.

The main building, the largest wood-truss structure built in Michigan in many years, will be of one-story construction, except for a mezzanine 40 feet deep across the front, housing the drafting room. Offices will occupy the space below the mezzanine and will be 80 feet in depth.

The New Jersey plant of the Wright Aeronautical Corporation is being constructed of concrete by what is known as the "warspeed" process. It is claimed, that, using this process, factories can not only be built more rapidly than of wood or steel, but that, in the construction of a building with 2,000,000 square feet of floor space, there is a saving of enough steel to build a Navy cruiser.

This concrete building, designed by the Wright company in co-operation with Albert Kahn, architect, is literally being built from the roof down, the floors and walls being the final units to be completed. The building is a single-story structure with reinforced concrete columns and roof and unreinforced concrete floor. The design is such that the building may be easily camouflaged and is well suited to production-line operations.

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GLUED—Spars for new minesweepers being constructed for the United States Navy are hand-turned of selected spruce and are glued with a synthetic resin glue.

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GLASS BEARINGS

Replace Sapphires For Use In Instruments

Synthetic sapphires, used for years as pivot bearings in small electric meters, are now virtually unobtainable from Switzerland, former main source of supply. Hence there has been developed in the General Electric Laboratories a new type of high-alumina content glass which can be hot-formed into tiny bearings which satisfactorily replace the synthetic sapphires. Engineers say that, from a performance standpoint, there is little to choose between the new glass jewel and the sapphire for small instrument applications.

FIRE HOSE

Now Made With Minimum of Rubber

When a War Production Board order, earlier this year, cut the amount of new rubber which could be used in fire hose from about 17 to a maximum of seven pounds per hundred feet in the 2½-inch size, and correspondingly in other sizes, it had the immediate effect of making it impossible for manufacturers to supply hose meeting the standard of Underwriters' Laboratories and the specifications under which thousands of cities have been ordering such hose.

To help remedy this situation, Underwriters' Laboratories, after considerable experimentation and research, developed an emergency alternate specification for fire hose and manufacturers are now supplying hose built to the new specifications.

This new hose will handle equally as well as hose meeting Underwriters' Laboratories' regular specifications, the main difference between the new and the old hose being that the new hose will probably not last as long. Otherwise the performance characteristics remain much the same.

HARD RUBBER

Will Stand Relatively High Temperatures

Development by its research laboratories of a superior type of hard rubber made from Ameripol, the synthetic rubber which its chemists created, is announced by The B. F. Goodrich Company. According to a report just issued, the new synthetic hard rubber, before softening, will stand temperatures 100 degrees, Farenheit, higher than the best hard rubber made from natural crude. It is expected that the new development will extend the field of hard rubber, since it overcomes many of the limitations which had restricted the service of this type of rubber under extremely severe conditions.

Synthetic: extruded, molded

LACQUER CONTAINERS

Protected by Addition of Organic Chemical

The tendency of clear lacquers, alcoholic shellacs, and nitrocellulose solutions to corrode plain steel containers can be overcome by the addition of small quantities of a new organic chemical. This suggests interesting possibilities for lacquer packaging during the current limitations on tin supplies. Because of the relatively low cost of the new chemical, it is believed that its use may continue after the tin shortage is relieved.

The chemical, it is explained, reacts with the metal surface of the container to form an insoluble film, which, though of microscopic thickness, is sufficient to afford the necessary protection. Because of the nature of its formation, the film is self-mending in case of breaks. In normal clear lacquers, about one-half ounce of the chemical per gallon of lacquer is sufficient to produce the desired effect.

SILVER USES

Being Increased In Electrical Equipment

Just as Pizarro, conqueror of Peru, once shod his horses with silver in an emergency, engineers are now using the precious metal instead of tin, copper, and other scarce materials in electrical apparatus.

There is at least a little silver now, according to Harry A. Winne, Vice President of General Electric Company, in almost every motor, generator, transformer, or other piece of apparatus made by the company for the war.

"In many cases the use of silver adds to the cost, a consideration secondary to production at the moment," explains Mr. Winne, who is in charge of apparatus design engineering. "In such instances, its use is probably temporary.

"On the other hand, the use of silver in current-carrying contacts and in brazing alloys frequently results in an improvement in quality sufficient to justify the greater cost, and so for these purposes its use will not only continue after the war but probably will increase."

Silver is replacing tin in soft solders, alloys which require comparatively low temperatures in joining metals. In the past, these alloys have had a relatively high tin content, ranging from almost pure tin to a very common composition of 40 percent tin and 60 percent lead. Today, however, solders in wide use range from 20 percent tin, 1 percent silver and 79 percent lead, to 97.50 percent lead and 2.50 percent silver.

Substitutions of silver for copper are being made in brazing alloys, which require high temperatures for joining metals. One type of brazing alloy, widely used before the war, was composed mainly of copper, the remainder being silver and phosphorus. Now alloys with copper content as low as 16 percent are in general use. A typical alloy consists of 50 percent silver, 16 percent zinc, 18 percent cadmium, and only 16 percent copper.

Aside from saving tin by reducing the tin content of solders, brazing technique is now widely replacing soft soldering to conserve tin and copper. Brazing also, chiefly because of the silver present, is often quicker, more reliable, and produces stronger joints.

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LAMPS—The ordinary small Westinghouse Mazda lamp owes much of its lighting efficiency to the exactness of the diameter of its tungsten filament wire. This wire is so thin it is measured by weighing it on scales accurate to within 40 billionths of a pound. These scales are sensitive enough to weigh a penciled signature.

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FREEZING

Of Machine-Tool Parts Has Many Advantages

Of interest and importance to science, industry, and business is the development and perfection of the new Deepfreeze Santocel extreme low temperature metal chiller, manufactured by Motor Products Corporation.

Among the numerous applications of the metal chiller, made in portable form for ease and economy in use, is contraction in compound fitting of metal parts. This facilitates slide fits in assembly operation, relieves strain and possible fractures. Exhaustive tests by competent authorities also indicate that sub-zero tempering and stabilization of high-speed tool steel will produce a combination of hardening, strength, and ductility unobtainable by ordinary hardening or tempering. Therefore, the freezing system should have extensive use in the aircraft industry and by machinery builders, tool makers, automotive manufacturers, and so on.

In one of our illustrations is shown a freezing installation in a large machine-tool plant doing extensive war work. The operator is inserting a machine-tool spindle in the unit. This is done so that costly anti-friction precision bearings can be assembled easily and permanently without damage. This is of particular importance today because machine-tool manufacturers have been forced to employ some unskilled help; in assembling bearings with a drive-fit to shafts, care must be taken not to damage the bearing which is both costly and difficult to replace.

The bearing shoulder of the shaft shown is approximately two inches in diameter and can be shrunk .001 to .0015 of an inch in 40 minutes at 50 degrees below zero.

Freezing a spindle

Another use for the portable unit in this large machine-tool plant is shrinking steel sleeve type bearings used in cast-iron fixture housings for supporting and guiding precision boring spindles for airplane boring machines. The bearings are usually made .0005 of an inch oversize, or are longer than the bore in the cast-iron housing. The bearings are frozen to shrink sufficiently so that they can be placed in the housing with ease. When room temperature is again reached, the bearings will have expanded to an accurate and tight fit.

LEAD BEARINGS

May Prove to be Superior to Tin Alloys

A way to meet the tin shortage as it threatens one of the most important applications of this highly strategic metal is being investigated by engineers who believe they have now found ways to produce alloys of lead to take the place of tin alloys in bearings.

One of the most gruelling trials of these new lead alloys for bearings is being conducted at The Cooper-Bessemer Corporation, according to Ralph Boyer, chief engineer.

"Alloys with lead as the base metal have been put into bearings of the corporation's Diesel engines and air compressors, and from all indications they are doing very well," the engineer said. "About a year of testing will be required, however, to prove conclusively that lead is an adequate substitute. We have run our tests for the last several weeks.

"We have been forced to turn to lead as a base metal in place of tin, and now there is every indication that lead will produce better bearings than we have ever had before."

The present importance of tin in this application is brought out by the fact that bearings in every automobile being driven in the United States contain on an average about 7½ pounds of this metal, the bearings containing between 88 and 90 percent tin.

SUPERSEDED

Riveting Machines Replaced by New Welders

Evidence of how rapidly production techniques on war jobs are changing is given in the story of the giant riveters, only a year old, which soon will have outlived their usefulness in tank work.

Developed and built last year by one automotive company for its tank job, these giant machines are being laid aside because of the Army's recent decision to switch from the riveted to the all-welded tank.

To employ in tank production the cold-riveting process that had previously proved successful in automobile-body riveting, this company designed huge horseshoe-shaped riveters to do the job. Some stationary and others brought into position by overhead cranes, these machines exerted as much as 100 tons of pressure in squeezing rivets into place.

Frictional heat induced by this tremendous pressure expanded the nickel steel rivets and improved their strength, whereas in the previous method of heating and hammering, some of these qualities were lost.

This method was so successful that more than 95 percent of the rivets used in the tank hull were inserted by cold riveting. Hot rivets were used only in the tight spots that would not allow entry of the large machines.

Yet, experience gained from major tank battles such as took place in the Libyan desert last year prompted Army officials to switch from the riveted to all-welded tanks. One of the major advantages of the new model tank will be the ability of the all-welded hull's curved surfaces to deflect projectiles more readily.

Thus the giant riveters, which cost thousands of dollars to build, must be laid aside. They will, however, be made available for other war work.—*Automotive War Production.*

INDUSTRIAL TRENDS

TOWARD BETTER NUTRITION

The food that people all over the world eat, and the important industries which produce that food and make it available to the general public, are, without a doubt, going to be greatly and favorably influenced by a development that is largely an outgrowth of the present war. This development, the dehydration of a large variety of foods, was dealt with in its technical aspects in our issue of July, 1942. In even the short space of time that has elapsed since that article appeared, the industry has advanced measurably in its endeavor to provide greater quantities and a wider variety of foods than ever before.

When you think of dehydrated foods, don't think of them as being in the class of dried peas and beans, prunes, and similar staples of long familiarity. The dehydrated foods of today are as different from these old standbys as jerked beef is from a fine porterhouse. Not only are they different in their advantages but also in their qualities that show up in the final test of eating. Obviously, the main points that are aimed at in dehydration are the elimination of bulk and weight, the retention of all possible food values, and reduction of spoilage. In the older methods of drying foods, only some 50 percent of the water was driven out and spoilage was merely retarded; by modern methods it is possible to eliminate as high as 90 percent of the water or more and to so arrest the factors which induce spoilage that the foods so processed can be kept under almost any climatic conditions for months.

Our former article on this same subject told of cabbages that were dehydrated and compressed to small disks which, upon soaking and heating, resumed the appearance of the original, with all the aroma and flavor so appealing to the healthy appetite; of carrots, peas, and beans about which the same thing can be said. By now the list has been expanded to include almost every vegetable and fruit in common demand, plus eggs, butter, some meats, and even clams and oysters.

Some processes of producing modern dehydrated foods depend on dividing the food into small particles and submitting these to heat and controlled atmospheres by one means or another Thus the natural moisture in the cells of the foods is quickly and almost completely driven off, yet the cellular structure of the materials is not affected Herein seems to lie the secret of retaining the food value and flavor so highly important to the ultimate consumer It appears that the rapidity of driving out the moisture also seals in those elements in the foods that furnish such factors as vitamins and essential oils, and excludes the bacteria which contribute to spoilage

All this is not quite so simple as it may seem, yet to date many of the problems involved have been solved. Each species of fruit and vegetable requires different handling during the drying process, and even different methods of applying the heat to obtain the best result In some cases the finely divided material is placed on trays in ovens, in others it is applied to the outside of heated revolving drums. Some foods dehydrate best when they are placed in small trays that, hooked together like a train of cars, are hauled through hot tunnels.

So much for the technical side of the increasingly important dehydrated food situation; what about the industrial side? It took the war to bring the industry to its feet and start it ahead. Our armed forces require tremendous quantities of food, quantities which, in many cases, have to be shipped long distances with assurance that they will reach their destination without spoiling. Weight and bulk, also, have to be reduced to a minimum to conserve valuable cargo space. Into this niche fell dehydrated foods. They fulfilled every physical requirement in a highly satisfactory manner.

Despite all the advantages that dehydrated foods offer, the industry itself is still relatively small, largely because it lacked public acceptance until the circumstance of war forced recognition of it. Thus, at the time of writing, there are reported to be only 25 active producers of dehydrated foods of all kinds on a commercial scale although it is said that 132 concerns are in the process of getting ready for production. Membership in the National Dehydrators Association is now 40 as compared with only 12 in January, 1942. Then, too, there are the concerns which are now producing or planning to produce the equipment used by the dehydrators, container and packaging manufacturers, and the various suppliers, all of whom form a necessary part of the whole industrial picture.

It is impossible to be too definite today about production figures of any type, yet it can be revealed that total business in the dehydrating field was only $10,000,000 in 1941. In 1942 it is estimated that this will increase 10-fold and that 1943 will see still greater increases.

What this means for the future is not difficult to visualize. After the industry has served the armed forces through to the days of peace, its products will be used to feed the millions in devastated countries, its methods will be applied to smooth out the peaks and valleys of crop production throughout the world, and it will contribute largely to the abolition of the under-nourishment that is so prevalent in this country and abroad. This means of preserving foods, now being brought to a fine point of perfection, will indeed be the basis of an industry that can go far to remove the blight of hunger from every land and to solve many of the problems that have faced every phase of the food industry in the past.

WHAT ABOUT THE AIRLINES?

Recent announcement by the War Department that the airlines of the United States will continue under private ownership settles, for the time being, an important question about our air-transport industry. As is well known, of course, many passenger transport planes have been taken over for military use, leaving the airlines as a whole with only sufficient equipment with which, when operated on a faster turn-around basis, to continue operations on an air-milage reduction of 45 percent.

What, then, is the trend of an industry that is so important to business travel, yet is of even greater importance from the standpoint of military operations both here and abroad? Present indications are that the airlines may regain some of their equipment. This will become possible as plane production for military purposes steps up still further and current demands are satisfied With more planes available, it is entirely possible that schedules on commercial lines may be restored to their previous condition, or even expanded to greater proportions than ever before When this comes about, the airlines, with knowledge recently gained of improved maintenance procedure, and efficient utilization of equipment, will be in a better position than ever to provide the fastest possible means of transportation to all of our industrial fronts.

—The Editors

Cometary Tails

Added Light on an Old Perplexity: The Force Which Drives the Gases from the Nuclei

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

A few months ago (January 1942) we had occasion to speak of some recent results which had been derived by the spectroscopic study of molecules in astronomical bodies—comets among them. Some of the problems which were then puzzling have since been cleared up, and the story is worth telling.

First, as regards the composition of cometary gases: Dr. Swings, the Belgian astrophysicist now at the Yerkes Observatory, has identified three emission lines in cometary spectra, at 4231, 4238, and 4254, with strong lines in the principal band of the ionized molecule CH+, which was detected last year in interstellar space. Some fainter lines in the ultra-violet are probably due to another ionized molecule, OH+, while good arguments can be advanced for attributing the fairly conspicuous unidentified lines near 4050 to NH+. This last interpretation can be verified only by production of the spectrum of this molecule in the laboratory—which presents a challenge to experimenters that, in normal times, would not long go without notice.

The list of molecules so far observed spectroscopically in comets looks very queer to the student of chemistry. It includes CH, NH, OH, CN, C_2, and also CH+, CO+, N_2+, and probably OH+ and NH+. None of these ten "molecules" is what the chemist would ordinarily call by that name. They are all fragments of molecules of the familiar kind and in an ordinary book on chemistry the first five would be called "free radicals" and the others "ions." In the laboratory, they are all "unsaturated"—eager to combine with anything available that comes near, and so form stable molecules of the common sort.

Dr. Swings points out that, though they are not chemically stable in the sense that they can persist in an environment full of other molecules and atoms, they are physically stable—that is, they have no tendency to break up of their own accord into separate atoms. On the contrary, the atoms which compose them are firmly bound together. They are still very ready to pick up other atoms or molecules—if they get a chance. But the gaseous parts of a comet are of such exceedingly low density that collisions of one molecule with another must be almost completely absent. The unsaturated molecules remain as they are, not because they won't combine with others, but because they don't get a chance.

There may be plenty of molecules of the familiar types, such as H_2O, CH_4, and NH_3, on comets, but we could not detect them if they were there, for the spectral bands which they would emit lie well out in the ultra-violet and are hopelessly concealed from us by the opacity of the Earth's atmosphere for such short wavelengths.

In fact, it appears necessary to assume the existence of these familiar gases in comets in order to explain that of the observed molecular fragments. The latter, as Swings points out, cannot exist in the solid particles which compose the main portion of the comet. If these particles are heated, when they come near the Sun, occluded gases may escape from them; but these will have saturated molecules of the familiar kind. Something else is needed to break them up, and this is almost certainly shortwave ultra-violet light emitted by the Sun. In many cases the absorption of such light may raise a molecule into an unstable state which automatically breaks in two. The fragments sometimes fly apart at high velocities with energy derived from the absorbed light.

Swings uses this to explain the long-known and perplexing phenomenon that the gases which form a comet's head sometimes escape from the nucleus with high velocity. No pressure sufficient to produce such speeds could conceivably occur in so rarefied a medium, but dissociation of the sort just described would account for it fully. The effect might be expected to be different for different molecules. In fact, CN is driven to a considerable distance from the nucleus, while CO+ stays close to it until light-pressure drives it off into the tail. This suggests that the dissociation process which forms the first is much more violent than for the second.

Once formed, these fragments find themselves in a region of such low density that they have very little chance of meeting any others. They are exposed only to the stream of radiation from the Sun, which fills all interplanetary space in its vicinity. If the molecules were capable of further dissociation by such radiation, it would not last long; but a molecule which escapes further breaking up may nevertheless absorb sunlight, get into a state loaded with energy and emit this again either as light of exactly the same wavelength, or as a closely associated line in the same band. This resonance process does not wear out the molecule and may be repeated indefinitely. There has been little doubt that the emission lines in cometary spectra are produced in this way; and now Swings presents a very conclusive proof. The emission of any particular bright line—say in one of the cyanogen bands—by gas in a comet means that cyanogen molecules had absorbed from sunlight, but a minute fraction of a second earlier, either this line or the closely associated one. The amount of light thus abstracted from the Sun, though enough to make the comet visible or even conspicuous on a dark sky, is too small to produce perceptible dark lines in the solar spectrum if the comet should pass between us and the Sun (as Halley's comet did in 1910).

Now these lines of the cyanogen band fall in a region of the solar spectrum which is full of wide and strong dark lines—produced by absorption in the Sun's atmosphere by iron and other elements. A cyanogen molecule in a given state of rotation has two absorption lines. If both of these fall within wide dark solar lines, very little energy will be fed into this particular molecular state from the sunlight, and the corresponding emission lines in the comet's spectrum will be faint. But if one or both of the absorption lines fall in bright regions of the solar spectrum, the emission lines from this state will be strong. In this way it is found that the apparent division of the cyanogen bands into two parts, one emitted by very slowly rotating molecules and another by those rotating much faster (of which we spoke last January) can be explained by the fact that molecules rotating at intermediate rates have their absorption lines falling on wide dark lines in the solar spectrum, while the others do not (at least to the same degree). The hypothesis that there are really two groups of molecules, one rotating fast and one slow, can now be abandoned.

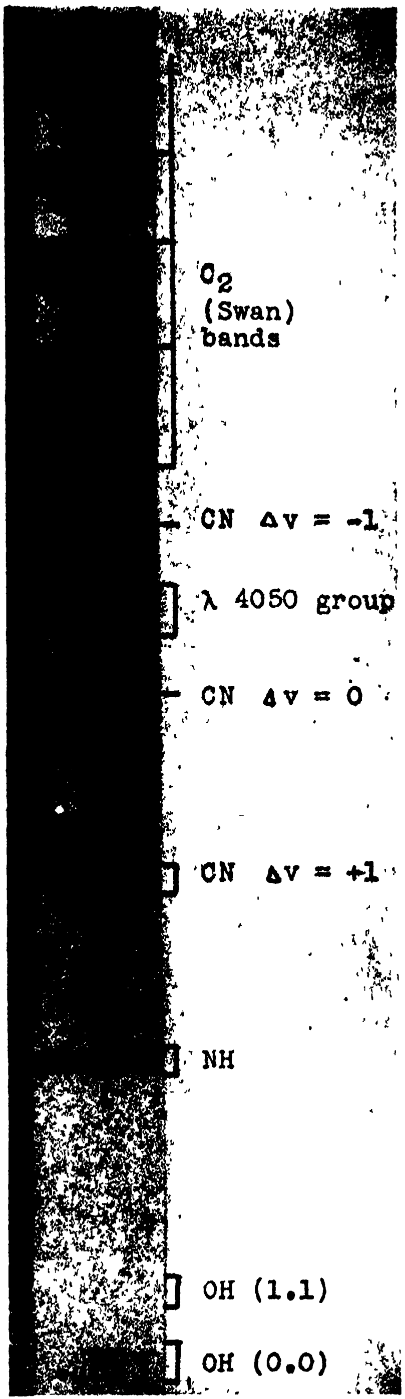
Just what the average rate of rotation of a molecule—and hence the temperature of the cometary gas—may be is harder than ever to determine, but it is little, if any, above 300° K—that is, "room temperature."

When a comet is rapidly approaching the Sun, or receding from it, the positions of its absorption lines are shifted relative to the solar spectrum. In some cases this changes the intensity of the sunlight available to excite the resonance lines. Differences have been observed in the intensities of details of the cyanogen bands in different comets which are fully explained by this. No more satisfactory proof that the radiation of comets is excited by the absorption of light from the Sun could be desired.

BAND-SPECTRA, as is well known, enable us to distinguish between the different isotopes of the same element. Carbon, for example, has an abundant isotope of mass 12 and a rarer one of mass 13. The molecule $C^{12}C^{12}$ is responsible for very strong bands in comets. Three bands of $C^{12}C^{13}$ lie clear of these stronger ones, and have been observed, though faint. The heavier isotope is therefore the less abundant in comets, as it is on earth and in the red carbon stars.

These carbon bands do not show the remarkable gaps, or faint regions, which the cyanogen bands do. They fall in a region where the solar spectrum has only weak lines (compared with the ultra-violet where the cyanogen bands lie) so that this is as might be expected. It appears, however, that the faint bands of OH^+, which fall in a region full of strong solar lines, are subject to irregularities of intensity.

All the cometary gases which have so far been observed are composed of four elements—hydrogen, carbon, nitrogen, and oxygen. In some comets which have come near the Sun, and been more strongly heated, the sodium lines have appeared. One of the tragedies of spectroscopy is that the great Comet of 1882 appeared before modern methods of photographing the spectrum existed. It came within a million miles of the Sun, and must have been hot enough to volatilize anything. Its spectrum at that time was examined by one or two visual observers, and seen to be full of bright lines, but no more is known. It was bright enough to have been observable with the most powerful spectographs. Ten minutes with a modern instrument might have given us information for which we may now have to wait till this comet returns, after some 600 years. Most of the other elements which are known to be abundant in the Sun and stars have a very poor chance, if any of showing up in the spectra of comets at ordinary distances from the Sun. The metals and their silicates are not vaporized or even melted. Helium and neon are very abundant, but their resonance lines are in the extreme ultra-violet and unobservable. It is probable that their atoms, if present near a comet, would be subject to very little light-pressure, as the solar spectrum is weak in these regions, so that they would not go into the tail, though they would diffuse away into space from the head.



Courtesy "The Astrophysical Journal"

Comet band spectrum, 3000—6400

Sulfur forms compounds which, like those of oxygen, have bands in the accessible region of the spectrum. When these have been well enough observed in the laboratory, it would be interesting to look for them in comets, though they might be very faint.

IT is hardly practicable at present even to estimate the quantitative abundance of the elements in the cometary gases. Apart from the question of the intensity of the solar spectrum in the region where absorption occurs, we would need to know the absolute absorbing power of the molecule for each line before we could calculate how strong they ought to look. An interesting example of this is found in interstellar absorption. The lines of neutral iron, recently detected, are even fainter than the strongest line of neutral calcium. But it is known that the absorbing power of a calcium atom for this line is very much greater than for all the other lines put together, which it absorbs when in its normal state. For iron, however, laboratory measures show that the absorbing power for the observable lines is less than two per-cent, on the same scale. As regards detection by interstellar lines, iron is therefore at a disadvantage of 50 to one, compared with calcium. Not much is yet known about the absorbing powers of molecules, but there is good reason to believe that it is much greater for the CN molecule than for OH—at least, for the observable bands. The fact that the hydroxyl bands are weak in comet-spectra compared with the cyanogen bands does not prove that cyanogen is more abundant.

A great deal of very interesting and probably remunerative work remains to be done on the spectra of comets. Unfortunately, it is only for a small part of the time that comets bright enough to be observable with high dispersion are visible.

Refrigeration For Insanity

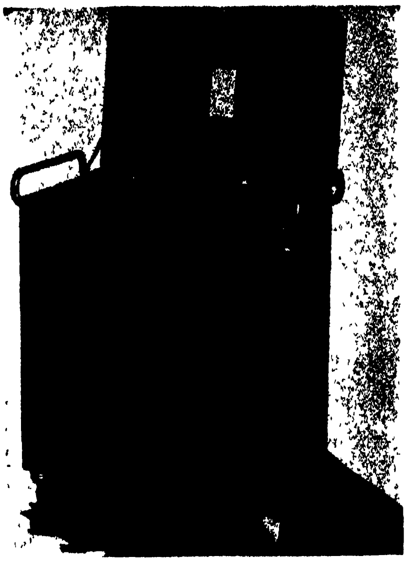
Hibernation at Lowered Temperatures Promises Value as a Treatment . . . Delayed by the War

BARCLAY MOON NEWMAN

The most promising of all the researches that have been undertaken in the clinics that use refrigeration of the whole body as a medical measure has, unfortunately, been temporarily postponed by the war. For the first time this new therapy, popularly known as human hibernation and technically as hypothermia, has apparently found a definite, valuable application—in treating insanity, particularly schizophrenia or dementia praecox. Results in the cases studied have been remarkable, so that more extensive investigation of the possibilities and limitations of this treatment will surely be forthcoming at the war's end, if not before

Decidedly a milder and less risky procedure than insulin shock, a treatment for insanity that was developed several years ago, hypothermia gives evidence of being more effective. Cases that did not respond to shock therapy have been markedly benefited by the hibernation treatment.

The modern psychiatrist already has been able to prove a great point: that mental illness need no longer be regarded as hopeless. Succeeding to an inspiring degree where centuries of effort went for nought, the new psychiatry has improved the mental conditions of thousands, and has effected some actual cures. Through insulin or metrazol shock, many schizophrenics have been restored to a practically normal state—though, too, there have been many failures and relapses. Hope for restoration under these treatments is generally limited to the first years of illness, presumably before the course of the disease has brought about irreparable degeneration and actual structural changes in the brain. On the other hand, there have been too many accidents—fractured vertebrae—during the violent convulsions occasioned by the treatment. Both insulin and the other commonly used drug, metrazol, notoriously often damage the brain tissue—though the very effectiveness of the treatment may be the result of structural changes that cut the activity of overactive centers. To many psychiatrists this is a dubious procedure. Dubious for a similar reason is the actual removal of cores of tissue from the brain, an operation now being tried here and there in "hopeless" cases and overenthusiastically described in popular articles despite the protests of the American Medical Association. Insulin or metrazol shock for schizophrenia, and fever therapy for brain syphilis, have nevertheless more advantages than disadvantages, and have justifiably been established in medicine. If, however, discovery of equally effective but milder, safer therapy can be made . . . .



Courtesy Therm-o-Right Products Co.

Instead of a bed of cracked ice a thermostatically controlled electric refrigerator may be used

So ran the train of thought in the minds of two Harvard Medical School psychiatrists, John H. Talbott and Kenneth J. Tillotson. Well up the temperature scale, Talbott had made important researches on heat cramps and the scientific evaluation of the ill effects of heat upon workmen. He and Tillotson, like every alert medical scientist, had been struck by the recent bold venture of Dr. Temple Fay into the strange world of refrigerated life in the treatment of cancer. Though beneficial in a limited number of cases, human hibernation as a treatment for this disease was not winning extensive application. Obviously, judgment of its value in cancer must await decades of further study. Also, just as with insulin shock and with metrazol therapy, both of which were first used on drug addicts, human hibernation could be applied in the treatment of morphine fiends. A few addicts painlessly hibernated through the first, usually dreadful, days of deprivation of their narcotics. Here, again, some additional alteration in the nervous system is induced by the treatment. The addict loses his craving, at least for a long period after refrigeration Similarly, in tests with cancer patients who were suffering intense pain, a mysterious nervous change is brought about by hypothermia. Though no drug is administered, the patient often is free of all pain, sometimes for months after the stay of a few days in cold storage.

Talbott and Tillotson looked up the published records of Fay and his Temple University associate, Lawrence W. Smith, professor of pathology, who summarized the effects of prolonged hypothermia on normal tissues, including brain cells, as follows:

"Only rarely are significant structural changes observed in normal tissues even when subjected to prolonged local refrigeration for as much as five and one half months Under general refrigeration such changes as do occur are insignificant."

Hypothermia, concluded Talbott and Tillotson, acts like an anesthetic and does not shock the patient as do large amounts of insulin or metrazol Like insulin and metrazol, hypothermia is associated with a significant alteration of the internal environment of the tissues. We have become accustomed in recent years to thinking of the treatment of mental disorders in terms of procedures which produce profound alteration of the internal environment of the body. But insulin and metrazol cause demonstrable structural changes and perhaps irreparable damage Hypothermia does not cause such damage or any demonstrable change in the structure of brain cells.

The two psychiatrists, aided by a generous grant from the Lucius N. Littauer Foundation, carefully learned the medical intricacies of general refrigeration and turned for facilities to the medical research laboratory of the Massachusetts General Hospital, where many famous discoveries have been made. (The Corn Industries Research Foundation supplied additional aid.) They selected patients who had not responded to insulin or metrazol.

The majority were negativistic, showing the aversion response to all social contacts and communications. Some were irritable, aggressive, impulsive, and for the most part, in extreme psychotic states, representing that seemingly unsurmountable barrier between reality and unreality, in which fantasy and confusion seem to produce a mental state with extreme negativism and a struggle even against the factors fundamentally essential to the organism's life, such as the taking of food.

All patients had been diagnosed by five or more psychiatrists as schizophrenic. They were all physically normal.

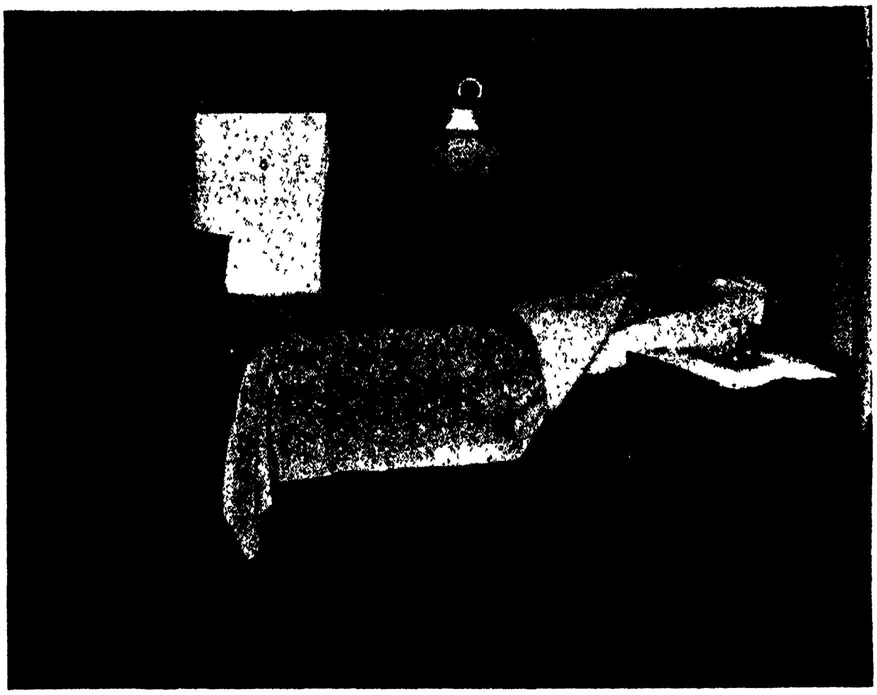
Miss P. M., aged 38, had been sick for eight years. Her clinical course was unaffected by refrigeration.

Miss B. R., aged 41, had been a schizophrenic since the age of 21. For the last ten years she had done no more than vegetate. She did not respond.

Miss S. E., aged 29, had been mentally ill for more than four years. In 1938 she had received two series of insulin shock treatments, resulting in only temporary improvement. On June 12, 1940, refrigeration was tried. Her temperature was maintained below 98 degrees for a total of 38 hours during the first treatment, for 34 hours it was kept below 95, and for seven hours it was below 80, actually falling for a short time as low as 75. She was drowsy and unco-operative for the first day after being warmed up again. Then for two days she was mentally clear—not only displaying a close approach to normal responsiveness but even becoming co operative. She evanescently exhibited a surprising insight into her condition and vouchsafed that she must have been confused for some time. All who saw her believed that she was better than she had been for more than two years. But after 48 lucid hours she reverted to her former state.

A second treatment followed on October 12. Twenty-nine hours of hypothermy brought only disappointment to the psychiatrists.

A third treatment was given in November, and refrigeration was prolonged to 54 hours, though the minimum thermometer reading was 87 degrees. After 12 hours of restored warmth, she became mentally alert, oriented, able to carry on a normal conversation, yet somewhat suspicious for three days. Since then she has been more responsive and co-operative than before treatment, though maintaining only partial contact with reality.



Connected to the electric refrigerator is a cold "blanket"

Miss H. I, aged 37, sick since 1923, had received several insulin shock treatments without benefit. Refrigerated for 33 hours, she improved markedly through five days, being pleasant, co-operative, appreciative of things done for her. But she reverted to her former state on the sixth day. Three months later, she was made hypothermic again—for 68 hours. As her temperature was allowed to re-approach normal, she became mentally clear and carried on a lively conversation about many topics in a logical and coherent manner—but only for six hours, until her temperature reached 95, when she became confused again. The next day she became lucid again, and for a day and a half gave every appearance of a normal and completely recovered individual. She wrote a letter to her mother and father. She was sociable, courteous, and an interesting conversationalist. Then she slipped back into her mute psychotic state.

If you will note the ages of these patients and the durations of their sickness, you may conclude that the response, if any, is disappointing in older, chronic cases. Yet a discovery is obvious. The mentally ill do respond. Presumably, as is speculated in regard to failures with insulin and metrazol shock, cases of long standing suffer irreversible brain-cell changes. Younger, newer cases provide confirmatory evidence.

S. R., aged 16, was first hospitalized in April 1940. In July, his body was sent below normal warmth for 27 hours, below 95 degrees for six hours, and to a low of 92. During the succeeding four months he improved. His hallucinations and queer ideas vanished. Quiet, polite, friendly, he was discharged as sufficiently improved to live at home.

Miss M. F., aged 25, had had symptoms for about ten years but was first diagnosed as frankly schizophrenic in April 1939. Neither insulin shocks nor metrazol altered her state. On July 29, 1940, general hypothermia was tried. Her temperature was kept below 98 degrees for 29 hours, and below 95 for 22 hours, at one time reaching a minimum of 83. "The adjustment of this patient outside the hospital," Talbott and Tillotson report, "had been unsatisfactory because of hallucinations and ideas of a bizarre, delusional type, and she had had to be confined intermittently. Following hypothermia she returned to her home, and at the last follow-up report it was apparent that she had made a good social recovery and a satisfactory social adjustment."

The most interesting case studied is that of Miss H. A., a medical student, 26 years old, admitted to a mental hospital in 1937. Her disease did not respond to either insulin or metrazol. She was the sickest of the group, but:

"During the first hypothermia treatment, when her body temperature reached 89 F., she commenced to talk. For all practical purposes, that was the first time that she had conversed in more than two years, being for the most part mute and combative. She talked clearly, logically, and with insight, and expressed herself normally until her temperature reached 93 F. At this level her conversation became confused and her speech thick. During the four intervening hours she had looked and acted quite normal and could not have been diagnosed as suffering from schizophrenia. When her temperature reached 96 F., she became mute and reverted essentially to her former schizophrenic state."

For three months her conduct was but barely improved. She was less combative, yet refused to talk.

After another two months she was refrigerated again. She repeated her previous performance. When her temperature reached 88 degrees, she became mentally clear and conversed for nearly four hours with her father, a physician. But, as before, when her temperature was raised to 94 she became once more unresponsive and confused. As her temperature approached 96 she was mute.

The following month brought no improvement. A third treatment induced the same queer response. As her temperature reached normal, she reverted again, and remained mute, combative, unco-operative.

At the end of 48 hours, however, she suddenly came out of her schizophrenic world, asked for her personal effects, expressed a desire to dress, requested her eyeglasses so that she could read. Once more she was herself, an intelligent, social personality.

For two weeks she stayed well. Thereafter, she tended to fall into moments of confusion, became overelated and boisterously active at times. Still, her general improvement has been sufficient to permit participation in occupational therapy, and a "fairly adequate social adjustment" has endured.

These and other striking results justify further investigation of hypothermia in insanity. In the words of Talbott and Tillotson:

"A more comprehensive statement and a definite conclusion will have to await further application in a far greater number of patients together with a longer follow-up study. The clinical results seem to be at least as promising as insulin and metrazol in the treatment of schizophrenia. That hypothermia may be beneficial in various phases and types of manic depressive psychoses is a subject which we hope to investigate in a similar study, presently."

A search of the medical literature showed Talbott and Tillotson that their success was not the first. A century and a half ago, in 1798, Dr. James Currie, Liverpool (England) Hospital physician, reported how he benefited a young man frenzied by insanity. Currie ordered the patient to be thrown headlong into icy water. "He came out calm and nearly rational," Currie wrote, "and this interval of reason continued for 24 hours. The same practice was ordered to be repeated as often as the state of insanity returned. This direction has been followed, and two days after the first treatment, he was thrown again into the cold water bath at the height of his fury as before. As he came out, he was thrown in again, and this was repeated five different times, till he could not leave the bath without assistance. He became perfectly calm and rational in the bath and has remained so ever since."

Modern psychiatry had to wait for Fay to astonish medical scientists by showing the safety of human hibernation in a bed of cracked ice—refrigeration which you had better not try out in your home since there are many fine medical points to be considered with the utmost care during hypothermia; respiration, heart beat, possible frostbite. For example, a temperature tumble below 75 degrees may be fatal. In human hibernation, life comes as close to death as it is possible to go—and return safely. In the weird world of cold life, you are suspended in the mysterious dark that lies midway between life and death. A medical expert can send you without risk into that dark icy slumber, but even he must have first rate hospital facilities.

The present writer has had a letter from Dr. Talbott, who replied to a query regarding new research: "Due to my participation in our war effort I have been forced to discontinue the hypothermia treatments, and probably shall not resume them for some time to come." One more charge against Schickelgruber.

Resumed these researches will be—of that we can be sure.

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BETTER TESTS

Why Are So Many Being Rejected for the Draft?

Is our national health declining? Such is the suspicion voiced by some who have read about the results of tests on selective-service registrants and note that, in the present war, a large proportion have been rejected. The true reason is rather the opposite—health is better, but medical science is today able to detect ills which, in the last war, were not found until the men were in service and which cost the taxpayer money because men likely to develop disease were inducted. In *The Journal of the American Medical Association,* Leonard George Rountree, M.D., Colonel in the United States Army Medical Corps and Chief of the Medical Division of the Selective Service Division, also Kenneth George McGill, Chief of the Research and Statistics Division, and Captain Oliver Harold Folk, Chief of the Medical Statistics Section of the Research and Scientific Division of the United States Army, have analyzed the health of selective service registrants and they find that:

"Advances since 1918 in clinical medicine and diagnostic laboratory procedures now present the means of eliminating more men from the service. For example, many registrants are being rejected because of latent syphilis that would not have been recognized in the World War. Chest roentgenograms are being used extensively. Many cases of tuberculosis are being found now that could not previously have been detected."

ELECTROCUTION

Home Treatment by Electric Devices May be Dangerous

In a communication to *The Journal of the American Medical Association,* Dr. Richard Kovacs of New York has described a tragic happening and observed that any kind of self-treatment with electric devices may cause death when applied by the inexperienced.

A resident of Long Island was found lying on the floor of his bedroom, fully clothed except for his coat. A metal electrode was on the back of his neck, slipped under the collar and held in place with a scarf. A wire led from the electrode to the radiator and was wired to the radiator. A rheostat was plugged in a wall socket, the handle of a "violet ray" machine was on the deceased's chest and a circular hollow piece of metal was in his left hand.

To reconstruct the sequence of of events, the deceased undoubtedly attempted to treat a back pain with the violet ray contraption and, in the mistaken belief that "grounding" would increase the strength of the current and thus the efficiency of treatment, after plugging in the handle of the violet ray outfit, rigged the connection between the radiator and the metal plate on the back of his neck.

No better way could have been devised to conduct the alternating current from the return ground through the heart area. Hence, as soon as the current flow was started, it caused local burns at the point of entry and instantaneous death.

OUR *Point* OF VIEW

YOU CAN'T SHRUG IT OFF

As these words are written, our Navy and Marines have re-taken from the Japs some islands in the southeast Pacific. By the time this is in print, we may know what it cost to drive the yellow men from those points. By then, too, we may have some conception of the cost in American lives of the presently-promised Anglo-American air offensive over Germany and of the Ranger raid on Dieppe. None of these costs will be nominal. The price we will pay to recover other Axis-infested parts of the world must not be forgotten as easily as were the oft-published traffic injuries and fatalities after each national holiday, before G. R. (Gasoline Rationing). So long as the individual was not concerned in one of those frightful highway tolls, the initial shock was easily shrugged off in favor of baseball scores, golf tournaments, or editorial comment.

There is something altogether too reminiscent of that careless casualness in the present attitude of the average American toward the bloody Armageddon now raging throughout our world. With far too many of us the ghastly awakening shock of Pearl Harbor has all but worn off. Although subsequent engagements with the foe have brought succeeding casualty lists; although our merchant ships, with a horrifying percentage of their crews, have been sunk faster than we can make them; although our armed forces, in about a year from now, will number at least half again as many men as we mobilized in World War I—compared to an army of 188,000 before the war; although our national life has been regimented and rationed as never before; although we have lost the Philippines, part of the Aleutians, and other possessions; although, in fact, we are losing the most important war of our existence, there are still too many of us who don't know what it is all about, who have no real conception of the super-seriousness of things as they are today—and who, in some cases, don't give a damn.

Why? What's wrong?

Doesn't the fact that naval casualties to date have exceeded those of the other war (77 officers, 794 men) by thousands mean anything? Doesn't it register that the man-power loss in killed, wounded, and prisoners in the single campaign of Bataan nearly equalled the total killed in action in the former A.E.F.? Can't we all understand that this is not a stream-side picnic of happier days? Is it beyond our conception to realize what it means to have the grasping tentacles of the Axis Powers increase their control of world production since 1938 over rubber from zero to more than 90 percent; crude petroleum, from 4 to nearly 7 percent; bauxite, from 25 to 65 percent; tin ore, from 9 4 to 73 percent; zinc, chrome, iron, and manganese ores, in comparable percentages? Today, we, the United States of America, are a have-not nation in so many crucial items that one wonders how we ever had the temerity to say: "We don't need the rest of the world. We can live unto and by ourselves."

The implications of these and other statistics not only are vital—they are vicious! We *must* wake up! We *must* understand, or else . . .

Again, why? What's wrong with us?

Outstanding among several contributing factors are two: the ever-more confounding confusion regarding availability of gasoline, fuel oil, rubber, clothing, sugar, other foods, and various daily-life items—for which only the government and its multifarious bureaus, departments, committees, "spokesmen" and their continually conflicting reports, estimates, theories, and what-have-you's can be responsible. Who knows whom to believe and what? And if we can't have dependence on what our leaders say about some problems, why should we get into a dither about their other pronouncements? Let us have clear, keen, truthful statements—facts, honest facts, even if they hurt—from sources known to be responsible. Then that irritable, self-satisfied, smug, what-the-hell attitude will largely disappear. Every John Q. Public will then find that he *is* concerned, that he *must* take greater cognizance of what goes on at Tulagi, at Stalingrad—or his way of life and that of his children will submit to the now too largely disregarded Axis menace that so threateningly overshadows him.

The other primary factor concerns us—each and every one of us, regardless of what sacrifices we may have made, or think we may have made to date. "There is no doubt that the American people mean to win the war," said Elmer Davis, "but there is doubt that all of us realize how hard we are going to have to work to win it. The war is a long way off . . ."—and that is one of our troubles. It was a long way off from France and England in late 1939 and early 1940, when German and French soldiers fraternized across the Maginot Line, when British aircraft dropped leaflets instead of bombs on the Reich. There was international smugness and things weren't too tough. Then it happened.

So it is with us. We haven't heard screaming Stukas or Zeros. Bombs haven't—at this writing—smashed buildings, torn our women and children limb from limb. It's all so far away—and it probably won't get over here anyway. The Germans are too busy with the Russians; after Midway and the Coral Sea the Japs aren't strong enough to attack our mainland. Let George do it!

So? *This* is a total war, and the word "total" has no half-way meaning. In total war you either are, or you aren't; you either live or you die, individually, nationally. We must recognize the gargantuan size of this conflict, its hideous, world-wide machinations. It is a known fact, now, that Axis strategy includes the conquering and subjugation of the United States. It can be done, both physically and economically, by the most ruthless, coldly-calculating, best informed, cruelest gangsters and mobsters the world has ever known. As matters stand this minute, only one thing can stop them and lick them—American ingenuity and courage, coupled with those same, already demonstrated factors on the part of the folk of the United Nations.

To accomplish our share, we Americans need two things: an administration policy that will give us the clear, cutting, unadulterated truth, so far as is compatible with national safety in war-time; and we, the people, must realize we have no surplus of resources, productive capacity, or time—that this is a fight to the finish, and that more of us must get more than "ankle-deep" in this war, or we'll lose it.

—A.D.R., IV

Future Sources of Power

A Systematic Survey and Evaluation of All the Power Sources at Present Known to Science

C. C. FURNAS, Ph.D.
Professor of Chemical Engineering,
Yale University

THE sun's rays shower as much energy on the earth's surface in one minute as the entire human race utilizes in one year. Despite the presence of this bountiful and unusual flow of energy, a large part of the struggles of the human race are concerned with acquiring and controlling sources of power. Evidently our state of development in the utilization of power is still rather crude. Thus, a review of the various practical sources of the present day is in order.

The energy supply which is most critical in America is that of petroleum. At the present time we are using something over a billion barrels per year. The known proved reserve of petroleum in the ground is 12 to 15 billion barrels, depending on who does the estimating. Thus the petroleum actually in sight is only about a 12-year supply. But new discoveries are being made constantly, so most of the people in the petroleum industry say they are not worried about the supply, at least for the present generation. It is a little discouraging to note, however, that the new discoveries are not quite keeping pace with use, so the pinch of partial depletion may come sooner than the optimists anticipate.

There may be discoveries of great new fields but the prospects of that are not very good. There is the possibility of extensive fields lying under the ocean next to coastal plains such as border the Gulf of Mexico. There may also be a great deal of petroleum at far greater depths than are yet explored. We live in hope that there are, but it should be remembered that if recovery is made from the more difficult places, the cost of production is certain to rise and the customer must pay for it.

Technical advances in refining have greatly extended the potential life of the petroleum resources. The widespread utilization of cracking has more than doubled the yield of gasoline and hence has more than doubled the potential supply of motor fuel. Now the polymerization of refinery gases into liquid fuels is beginning to come in and is helping to extend the life line of petroleum. Such technical advances are a great factor in keeping up the liquid fuel supply, but eventually, perhaps distressingly soon, the pinch of depletion will begin to make itself felt. What then?

There are several possibilities that need to be surveyed and evaluated:

Dr. Abbott and experimental sun power plant

I. Getting all the petroleum out of the ground. Even with the best production methods, over half the original petroleum deposit still stays in the ground after the well has gone dry. Mining of the sands appears to be impractical, not to mention being very expensive. If some one will devise an inexpensive means of breaking the adsorptive forces between petroleum layers and the sand grains, he will greatly lengthen the life of our oil resources, not to mention the possibility of making himself rich.

II. Shale oil. There are many billions of tons of oil shale in this country which, when heated, will yield from half a barrel to two or three barrels of petroleum-like oil per ton of shale. The potential supply is enough to supply our motor fuel for from 100 to several hundred years, depending on the grade of shale considered acceptable. But mining or quarrying the shale, retorting it, and disposing of the waste costs effort and money. If the refinery cost of gasoline should double above its present cost per gallon, then shale oil might begin to compete. Thus we have a considerable backlog of motor fuel but we shall get it only by paying higher prices than at present.

III. Hydrogenation of Coal. Germany and, to a certain extent, England are making fairly satisfactory liquid fuels by reacting hydrogen gas with low grade coal at high temperature and pressure in the presence of a catalyst. But the cost of production is about 20 cents a gallon compared to the American cost of five to six cents a gallon from petroleum. That high cost might be lowered somewhat but the prospects are that it will not go down materially. Thus we can drive our cars on motor fuel from coal, but we'll have to pay dearly for it.

IV. Alcohol from agricultural products. This is great fuel for politicians from the corn belt but not so practical for automobiles. First item is cost—15 to 20 cents a gallon under best practice. Next, lack of supply. A small fraction of our fuel might be supplied from waste and surplus farm products, but it would require nearly all the good crop land in the country to supply our motor fuel demand by this means. There wouldn't be anything left to eat.

Summarizing liquid fuels: We can have fuel for automobiles for at least several generations but at a price. The lush days of practically free oil from the ground will begin to end some of these days—probably too soon to please us This generation may very well feel the pinch of partial depletion. Any economy or conservation steps are very much in order.

Coal: In coal we are the most happily situated country in the world. We have over half of the world's known coal reserve, and less than 6 percent of the world's population. At the present time we have enough coal in sight (all grades) to last 3000 years. That picture may change if the other 94 percent of the people of the world decide that we must divide up, but that is one of the unpredictables. Hence as regards coal we may say that we are very lucky. But that does not mean we should be negligent of conservation. Within the next 100 years many of the best deposits will be depleted. We shall have to begin to depend on the lower grades. Expenses of recovery will go up, quality will go down. It will be wise to extend the life of our A-1 deposits as long as possible.

Eventually, no matter how much we conserve, this sponging off past ages for fossil energy must cease—the deposits will have gone up in smoke. What then? That's a question which America will face eventually, which many groups of people in the world are facing right now. Other possible sources of energy certainly should be considered.

I. Water Power: The water-power sources of the world are by no means fully developed, but even if they were they would be quite inadequate. About 10 percent of America's energy comes from water power. By full development that could be extended to 20 or 25 percent. It helps but it simply is not enough.

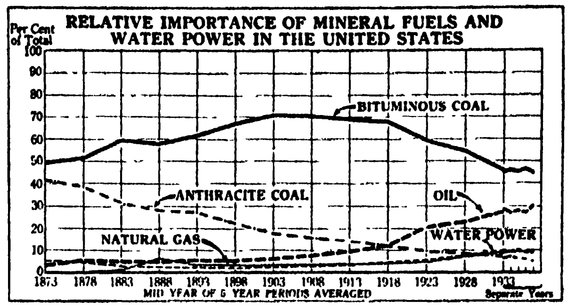
II. Wind: Lots of energy goes to waste in a hurricane or tornado but you can not count on it. The winds are not dependable, even in Kansas. Moreover, the average breeze is at a very low potential as far as energy is concerned. Except for isolated, special cases where a high cost storage capacity can be provided, wind power seems to be out.

III. Tides: In a limited number of places, such as ill-famed Passamaquoddy Bay, the use of tidal power may be practicable if a possible market is close at hand. Like the power from falling water, this may help but it can supply only a small proportion.

IV. Wave Power: Many wave motors have been designed, some of them have been patented. But the item of variability of the source of power seems to relegate this device to the impractical heap.

V. Utilization of Current Vegetation: About 50 times as much energy is stored up in plant life on the earth in one year as man utilizes in that year. It might then appear that we could use the present growing trees, grasses, and shrubs for fuel and thus solve the problem. Close investigation makes that idea discouraging. In the United States we would have to use nearly all our annual crop of vegetation (trees, grass, farm crops) to meet the energy demand. Nothing would be left to eat and the land would all be a desert in a few years. We cannot push vegetation very far from its natural cycle. All the data show that we cannot go back to a tree- and bush-burning economy.

VI. Atomic Energy: The business of smashing atoms to release great gusts of energy is a profitable sport—for news reporters But it is not an item that has much standing in physics laboratories. Radioactive materials, of which there are only minute amounts in the earth, disintegrate and slowly release large amounts of energy. If radium, for example, were as plentiful as copper, atomic boilers using radium as fuel might be practical, but there just is not very much radium available. As far as artificial disintegrations are concerned, the verdict thus far seems to be definitely thumbs down on such operations for giving a net yield of energy. Far more energy has to be put into the operation than can be got out. There is some evidence that one of the isotopes of uranium, if relatively pure, might, upon bombardment with neutrons, disintegrate to give a net yield of a rather large amount of energy. But this isotope of uranium is one of the rarest of rare materials. Other materials tried have not so far shown any hopes for energy production. Thus any Atomic Energy Development Company seems to be facing a stone wall of discouraging facts. One cannot arbitrarily say that we shall never be able to get energy from atomic disintegration but in our present forecasting we shall be on safer ground if we do not count on it.



Courtesy, "The Index," New York Trust Co.

Graphs showing trends in power sources

This brief survey has not answered the question of where we shall get our energy, but it has pretty well covered the possible sources—excepting one—the direct utilization of the energy of the sun's rays.

The average intensity of solar energy in this latitude amounts to about 0.1 of a horsepower per square foot. The energy falling on one square yard of roof would more than operate all the electrical household appliances, including lights, of the average family—if it could be directly utilized. Most factories have sufficient energy falling on the roof to operate all the machinery in the place—if the management had enough ingenuity to utilize it. No one has developed that ingenuity yet.

One of the obvious possibilities for direct utilization of solar energy lies in photo-electric cells. Thus far photoelectric cells have operated with microscopic efficiency and have been very expensive. If some one can make revolutionary improvements in photoelectric cells, and can cut the cost of construction away down, we might have something there. At present the prospects are discouraging but one hesitates to say that such utilization is forever impossible. Even with the items of efficiency and cost brought under control, the matter of storage of energy during periods of darkness would be troublesome. Large storage reservoirs of water might solve this problem—pumping water to high levels in daylight hours, using it in water turbines during darkness. The overall efficiency of such storage can be about 70 percent. In general, it may be said that photoelectric cells are barely possible but not hopeful.

The simple and obvious device of using focused sun's rays to heat up a liquid has been toyed with for a long time. Solar boilers of various degrees of impracticality have been born in many inventors' minds and the subject of many patents Dr. Abbot, of the Smithsonian Institution, has a small solar power plant with revolving parabolic mirrors for which he claims an electrical energy production efficiency of 15 percent. We shall have to do better than that if the sun's rays, which are not at very high intensity to begin with, are to be a practical source. It is not likely that the efficiency of the solar power plant, if it operates by steam generation, can be greatly improved.

On the other hand, solar energy may very well be on the verge of being practical for heating of buildings where a high potential is not important. The storage capacity must be sufficient for weeks or even months of operation. A basement full of hot water, periodically reheated by the sun's rays, might be possible, but it hardly sounds practical. A closed cycle, employing a low-boiling liquid, might better serve for such storage. First costs would be high but operating costs might be cut to the vanishing point.

Such an idea may bring a smile but it is now becoming almost respectable; the Massachusetts Institute of Technology has begun experimentation along this line. [See "Harnessing the Sun," Scientific American, June 1942, pages 284-286.—*The Editor*]

The foregoing suggest some interesting ideas but, with the exception of heating buildings, they do not seem to come within gunshot of practicality. I have saved what I consider to be the best idea until the last: namely, men should try to do efficiently what nature has been doing inefficiently for a billion years—utilize photo-chemical reactions. The basis of all life is some simple photo-chemical reaction thought to be

$$H_2O + CO_2 + \text{Radiant Energy} = HCHO \text{ (Formaldehyde)} + O_2$$

The formaldehyde immediately forms simple sugars which then serve as the basic material for the multitude of complex compounds in plants. What we should like to do would be to take some such simple compound as formaldehyde formed with the help of radiant energy, put it in an electro-chemical cell, expose it to oxygen, and then reverse the above reaction and get back the stored energy as electrical energy—at high efficiency. Formaldehyde can be oxidized in a cell in a basic solution to give formic acid and a small amount of electrical energy. Perhaps all that is needed is a proper catalyst to complete the oxidation to CO_2 and water and get back all the stored energy.

The catalyst which nature uses for performing the photosynthesis of the above equation is chlorophyll. That's the best catalyst known but it is very poor. Plants are very inefficient stores of energy. Even the most luxuriant plants have an energy-storage efficiency of less than two percent. We ought to be able to do a lot better than that.

It is a wide open field—this study of photosynthesis and the study of oxidation cells which will reverse the reaction. That is the reason it is hopeful. The systems which might be used would not have to be limited to organic compounds. It may well be that inorganic compounds offer the most hope. The satisfactory system would need to be one that is as light-sensitive as the chemicals on a photographic film, as easily reversible as a lead storage cell. If such a photo-chemical-electrical system can be developed, the problem of energy capture and storage would be solved. The storage of the energy would be simply that of storing chemical compounds. We are used to doing that with coal.

Some day the photo-chemical approach to energy utilization will either be solved or definitely proved impracticable. In view of our own energy resources it may seem foolish to start working on it now. But it may not be too early to start. If we wait too long we may be caught short as energy supplies dwindle. Moreover, many parts of the world already suffer from insufficient energy. Many international problems might disappear if every group of people could fully utilize the energy falling on its rooftops.

Enough energy falls on about 200 square miles of an arid region like the Mohave desert to supply the United States. When we become ingenious enough to utilize efficiently the energy treasure wherever it may fall we may solve many of our economic problems. It might be a little hard on the railroads that haul coal, but everyone else would benefit.

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FREE ELECTRONS

May Explain Behavior

in Iron Alloys

LOOSE electrons which float around between the atoms of solid iron and its alloys are responsible for many of the properties of these alloys, said Dr. Roman Smoluchowski, speaking recently before the American Physical Society.

He presented a new conception of the role which these "free" electrons play. Applied in practice, it may lead metallurgists to a better understanding of what happens when other elements are added to iron, making the alloys so important to industry, in peace as in war.

Atoms of iron, like others, consist largely of electrons, each carrying a negative electrical charge, encircling a positively charged nucleus. These atoms are arranged in a lattice formation, making up the metallic crystals.

But also in iron, as in all metals which are electrical conductors, there are other electrons floating around in this lattice, not connected to any particular atoms. The drift of these so-called "free" electrons is responsible for the conduction of electricity as well as of heat.

Pure iron at ordinary temperatures has a crystal structure in which the atoms are arranged in the form of interlocking cubes, the corners of each cube forming the centers of adjacent cubes. Thus they form what is called the "alpha phase" arrangement, and this makes for toughness and strength.

However, when iron is heated there is a change at the temperature of 900 degrees, Centigrade. It then goes from the normal alpha phase to the "gamma" phase. Here the atoms are more closely packed than in the alpha phase and the whole metal contracts slightly. If the heating is continued, at 1400 degrees, the metal changes back to the alpha phase, which is retained until it melts, at 1535 degrees.

When other metals are alloyed with iron, they form a solid solution, comparable to liquid solutions—salt in water, for example. Some alloying metals increase the range of temperatures over which the gamma phase occurs, while others decrease it or eliminate it entirely. Knowledge of their effects is very important to the metallurgist in planning an alloy for a particular use. If a part in a machine has to withstand a temperature of perhaps 1000 degrees, Centigrade, it would not do for the alloy of which it is made to change phase while in operation. One then has to add a metal which prevents formation of the gamma phase. On the other hand, a metal which would have this valuable property might introduce other undesirable properties, as for instance, lessened resistance to corrosion. Hence it is necessary to have a selection of alloying agents, from which the proper choice may be made.

All the 92 elements can be arranged by their atomic weights in a checkerboard fashion, to form the well-known "periodic table." Iron comes close to the middle. It has been found by previous experimenters, said Dr. Smoluchowski, that all the elements to the right of iron (and which can dissolve in it) increase the range of temperature at which the gamma phase occurs. All to the left, with a few exceptions which can be explained, decrease the gamma range, or eliminate it entirely.

According to Dr. Smoluchowski, this remarkable regularity is explained by changes in the energy of the free electrons in the crystal lattice of an iron alloy with the addition of other atoms. "The elements to the right of iron, such as nickel, cobalt, and platinum, have more free electrons per atom than iron," he stated. "Thus they contribute electrons to the iron lattice. In contrast, those on the left, including vanadium, chromium, tungsten and molybdenum, take them away."

Fluorescent Lighting Stretches Out

Cold-Cathode Tubes, Operated at High Potentials, Have Interesting Applications for Many Uses

AUSTIN C. LESCARBOURA

Fluorescent lighting is being stretched out as the next step in the spectacular development of tube lighting. Continuous cold-cathode fluorescent tubing, as distinguished from the usual hot-cathode fluorescent lamps with their fixtures, and in lengths up to 20 or more feet and in parallel lines, curves, circles, or other shapes to follow architectural contours or specific illumination needs, has been appearing of late in plants, drafting rooms, offices, stores, and other establishments. The fact that this improved fluorescent illumination utilizes all available light, since no diffusion screens are required; that it stretches out the total light over the widest area as contrasted with lamps spotted here and there in fixtures; that it does away with elaborate fixtures and accessories, and even reflectors where white ceilings are available; and that it requires an absolute minimum of hard-to-get materials, has earned for it the significant nickname of "the victory light."

Cold-cathode fluorescent lighting, however, is just another old idea in modern streamlined dress. Many of us recall the Geissler tubes of our physics classes or home experiments. Those glass tubes, blown or bent into decorative shapes and sometimes surrounded by fluorescent liquids held in outer glass jackets, were connected across a spark coil or static machine so that the electrical discharge caused them to glow in various attractive colors. Out of that old idea came the colorful and vivid neon and other gaseous-tube advertising signs that converted night into day along our Main Streets until blackout ordinances compelled reversion to the blackness of the night, and incidentally left thousands of neon sign shops without a reason for being —temporarily, at least.

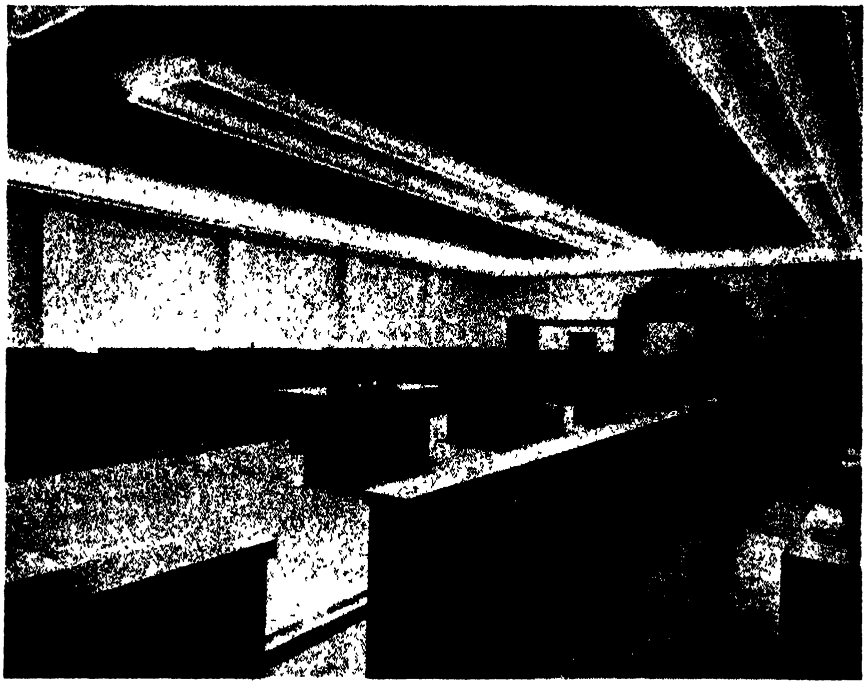
It so happens, however, that the neon sign technique can, with due thought and care, be converted into an advanced form of fluorescent lighting. First, tubing that emits a white light takes the place of the colorful tubing used for advertising displays and decorative purposes. Second, the manufacturer or contractor handling finished tubing and installations now thinks in terms of total lumens, and foot candles, and lumens per watt. Third, the industrialist, seeking the most satisfactory illumination for his workers averaging 60, 70, and even 80 hours weekly, is attracted to the easy-on-the-eyes merits of cold-cathode fluorescent lighting. Fourth, in order that there may be standardization of products and installation practices to safeguard the buyer against being made party to an experiment, the Fluorescent Lighting Association, comprising leading manufacturers of cold-cathode fluorescent products, joined by contractors keenly interested in this latest illumination means, is formulating and issuing definite standards covering approved products and installation practices.

Cold-cathode fluorescent lighting is probably the simplest form of illumination so far developed. It consists of nothing more than inside-coated glass tubing properly evacuated and filled with argon gas and mercury vapor, fitted with metal electrodes, and sealed. Such tubing can be straight or bent to any shape. Several lengths, each up to eight feet long or more, can be connected together in series, on one transformer. Parallel rows of tubing can be used where a higher level of illumination is required. The transformer steps up the 110-volt A.C. to the necessary secondary voltage required for the satisfactory operation of the tubing. Usual operating voltages run anywhere from 3000 to 15,000, depending on the tube footage, number of tubes in series, tube diameter, and other factors, all reduced to definite mathematical formulas and tables. The current flowing through cold-cathode fluorescent tubing is generally of the order of 60 to 150 milliamperes, depending on several interlocking factors. Tube diameter generally runs from 12 to 25 millimeters.

Tubes come close together in mountings, leaving minimum dark space between

What actually happens in the cold-cathode fluorescent tubing is that the coating inside the glass tubing is activated or caused to glow under the action of the ultra-violet light generated by the passage of current through the gas in the tube. The glowing phosphor or fluorescent coating causes the entire length of the tube to emit light. Thus the light is spread out over many lineal feet, instead of being concentrated—as in the case of the usual incandescent lamp—into a few square inches, or again into the 9-inch to 5-ft. length of the hot-cathode fluorescent lamps. The cold-cathode fluorescent tubing stretches out to many feet and, with this stretching process, the surface brilliance or glare of the tubing per unit area is correspondingly lessened. Referring again to the incandescent lamp, we have the light concentrated in a few square inches, with even the translucent bulb still too

Mountings are easily adapted to angular arrangement of the cold-cathode tubes



New lighting method is simplest form—no reflectors or diffusers

bright to permit such a light source to be used unshielded if we have due respect for our eyesight. The hot-cathode fluorescent lamp was a big step ahead, for the surface brilliance is considerably reduced as the light source is stretched out to four or five feet. Now comes the cold-cathode fluorescent tubing, stretching out to 20 feet for the same light output, and the surface brilliance is so lessened that one can look directly at such light source for hours without visual discomfort. Thus, in the case of cold-cathode fluorescent lighting, no diffusion means or translucent screen is required, which means that instead of sacrificing anywhere from 25 to 40 percent of the light output for diffusion purposes, the full light output is put to useful work.

The stretching of the light source also serves to distribute the light to best advantage. As contrasted to lamps in fixtures spotted here and there, the cold-cathode fluorescent tubing spreads over the area to be illuminated so that there are no light and dark areas, but rather a uniformly well illuminated area. Since this light source operates at a relatively low temperature, the tubing can be mounted close to a white ceiling, which ceiling then serves as the reflector. Simple hangers suspend the tubing. Where a white ceiling is not available, the tubing may be placed in suitably painted plywood reflectors. No metal is necessary for the reflector, and no other fixtures are needed except the simple connecting sockets.

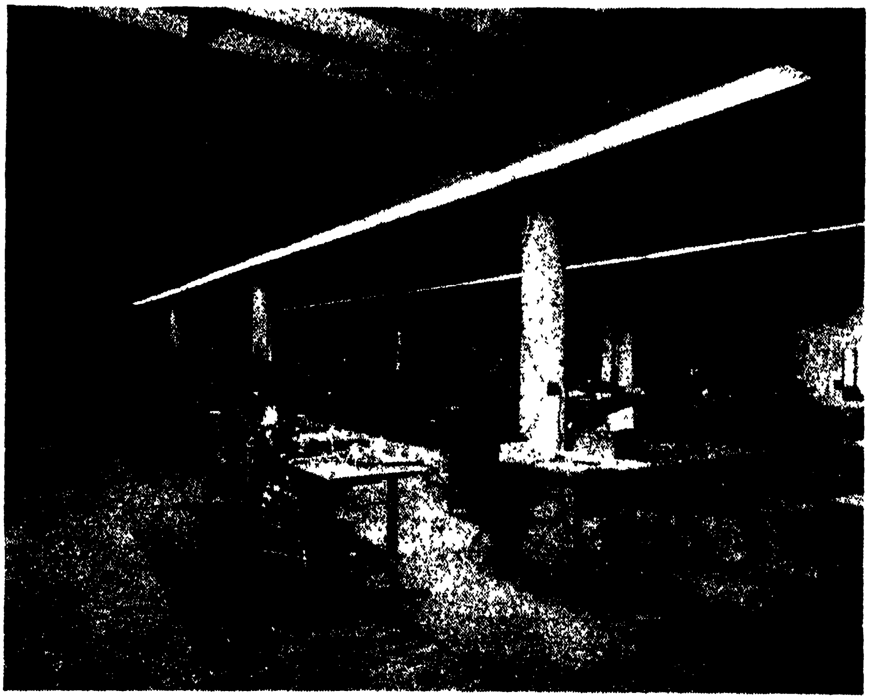
Although cold-cathode fluorescent lighting still is in its infancy so far as actual application is concerned, rapid progress is being made because of the Association's activities. Already suitable porcelain mountings are available, permitting the tubing to be held in series or in parallel, and at various angles in respect to successive lengths. Suitable transformers are available, and decorative housings are now coming through to dress up the installations in offices and stores.

Fluorescent tubing for utilitarian illumination comes in three shades of white termed "Soft White," which has a pinkish cast for a pleasing atmosphere consistent with good lighting; "3500 Degree White," in strict accordance with the color designation of that term; and "Daylight White" which is more on the blue side and suitable for revealing true color values.

The white range of fluorescent tubing is more efficient than that of incandescent lamps because the light output for the former is from two to four times greater than for the same wattage input, while the heat radiation is from 25 to 50 percent less. The latter consideration is important when dealing with showcase lighting, or in confined working quarters, or again where air conditioning is being used.

The simplicity of cold-cathode fluorescent lighting is another basic reason for the growing popularity of this form of illumination. There are no accessories or starting gadgets of any sort required. Just the tubing and the transformer complete the equipment proper. When the power switch is closed, the tubing lights up instantly, at full illumination. There is no delay, no sputtering, no flickering. With the absence of starters or accessories, there is virtually nothing to get out of order. The maintenance is reduced to nothing more than wiping off the tubing with a damp cloth from time to time, to assure full illumination.

As for life, typical installations show a tube life of 10,000 hours to as high as 30,000 hours in actual service, as



Typical shop installation. Transformers are above reflectors contrasted to the 2000-2500 hour rating of hot-cathode fluorescent lamps. Furthermore, there is little falling off in light output with cold-cathode fluorescent tubing, as compared with a considerable loss of light for both the incandescent and the hot-cathode fluorescent lamps as they age. Cold-cathode fluorescent lamps have no filaments to burn out or break from jars or vibration. Cold-cathode life is not reduced with frequent starting, whereas life is reduced with each starting of standard fluorescent lamps.

Because cold-cathode fluorescent lighting requires so little hard-to-get materials, particularly when freedom from replacement is considered, this form of lighting is receiving favorable priority consideration.

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GLASS

Now Made Without Use of Sand

In windows, glass is used to admit light; in optical equipment it must refract, disperse, or condense light, and better control of these functions has long been the aim of research.

Ordinary glass has as its principal constituent silica in the form of sand, whereas a new "rare element" glass, developed by Eastman, contains no silica as sand but, instead, various compounds of tantalum, tungsten, and lanthanum with boric oxide. Such a glass, suggested eight years ago by Dr. G. W. Morey of the United States Geophysical Laboratory and developed with his collaboration, has a refractive index high in relation to its dispersion, imparting to it unusual "light bending" ability. This makes possible a lens of considerably less curvature for a given focal length, which means that the path of rays through the lens margin will approximate more closely that of rays passing through the center. Practical application in aerial cameras with compound lenses gives better "definition" over a wider area, but with no loss of lens speed.

At present, "sandless" glass is being manufactured only on a small scale. Before it may be used generally for photographic lenses, different grinding formulas must be worked out, as its higher refractive power prohibits the application of standard silicate glass formulas. Even then, sweeping replacement of optical glasses now being used is not anticipated. Since the new glass is much more expensive, due to costlier materials, whose high density also increases the cost per volume, it will be substituted only where its superior ability to give improved definition over a wider area (as in high-aperture lenses) justifies the extra cost.—*Industrial Bulletin of Arthur D. Little, Inc.*

LIGHTNING CHARTED

To Provide Defense for Power Lines

To prescribe adequate defenses for power lines, Westinghouse engineers now plot lightning charts, called probability curves, to anticipate the approximate number of lightning strokes that will bombard power lines during a given length of time. It has been learned, for example, that every 50 miles of power line will be hit by lightning an average of 50 times every year. Each stroke will have a potential voltage of between 20 and 30 million volts as it streaks earthward from a cloud. Forewarned, power-line designers can erect defenses that prevent lightning strokes from short circuiting transmission systems and disrupting electric service to vital war industries.

Filmed measurements of lightning give data for "probability curves"

The lightning charts have been made after engineers spent four years measuring the power and speed of lightning, and gathering data on the number of times that thunderbolts strike in a given area. They found that an average of 10 lightning strokes bombard every square mile of the United States every year; that the average stroke consists of about 20,000 amperes of electricity (enough to momentarily light a city of 15,000 population); and that the speed of lightning varies between 30 million and 200 million miles per hour.

Such lightning data have produced a great improvement in the defense of power lines against thunderbolts during the past 20 years. Two decades ago nearly every one of the 50 lightning strokes that hit a 50-mile power line each year knocked out service at least temporarily. Today, a properly designed 50-mile power line is unlikely to be put out of service by lightning more than once in five or 10 years.

SWEDISH STEEL

Is Equalled by That Made in Texas

Steel smelted with charcoal in the Swedish way, and as good as Sweden's best, is an American product fostered by wartime changes in the world's industrial setup, according to Dr. Donald F. Othmer, of the Polytechnic Institute of Brooklyn.

Swedish steelmakers have always favored the use of charcoal in smelting because the absence of sulfur and other impurities from charcoal resulted in a very pure, high-grade metal. The Nazi war-lords have taken advantage of their position to monopolize all of Sweden's export production, and they may yet overrun Sweden itself. So we are getting no more Swedish steel.

At the same time, war-stimulated demands for two of the principal chemical products of wood—acetic acid and methanol (wood alcohol)—have caused a great increase in their production by the American wood distillation industry. By-product of wood distillation is a very high grade of charcoal, excellently suited for quality steel production

In northeastern Texas there is a great deposit of iron ore that has not been worked hitherto because it is too remote from supplies of coking coal. But all over the region there are forests of post oak, of little value for lumber but very good for wood distillation, and, of course, yielding high-grade charcoal.

By establishing one or more wood distilling plants in that region, it will become possible to turn out new supplies of the war-needed chemicals, and at the same time to convert part of the now neglected iron ore into the finest steel.—*Science Service.*

BRIDGE

For Railroad Crossings In Industrial Plants

Designed for use in industrial plants where loading docks and buildings are separated by roadways or railroad

Bridge in lowered position for crossing railroad tracks

tracks a new power operated cross-over bridge has been made available by the Montgomery Elevator Company.

Operation of the bridge is similar to that of an elevator. When not needed the bridge is housed overhead, out of the way. When loads must be trucked across the open space, a control button is pushed and the bridge descends into grooves provided for it. When trucking is finished, the button is pushed and the bridge automatically returns to its housing overhead. Time required for raising or lowering is less than one minute. This eliminates cumbersome drawbridges and special transfer cars. Danger to employees is also reduced because they do not have to venture onto the tracks or roadway.

FOREST RESOURCES

Heavy Demands Will Come After the War

The inroads that have been made by war into the timber capital of most European countries will inevitably result in a reduced forest productivity for a long period after the war, C. L. Forsling, assistant chief of the Forest Service, United States Department of Agriculture, said in an address prepared for the Second Inter-American Conference of Agriculture, held in Mexico City.

Following the war, he said, there is likely to be a heavy demand for lumber and other forest products for reconstruction purposes and to meet the normal needs that have been postponed during the war.

"There is reason to believe also that the demand for wood after the war will be large, not only in Europe but all over the world," Mr. Forsling said. "Although some of the supply to meet this increased need can come from other parts of the world, the Western Hemisphere, particularly the countries south of the Rio Grande, will have to supply the major portion. It seems reasonable to expect, therefore, that the countries of South and Central America and Mexico may have the opportunity to develop an export trade in timber. Domestic requirements, which naturally should come first, may be expected to increase.

The development of export trade and increased domestic use will require more knowledge than is now available about the potential uses of the large number of tropical American forest species and the improvement of facilities for marketing. A sound policy of conservation and management of forest lands is basic to sustain foreign markets and to insure adequate supplies for domestic needs in the future. Collaboration in a number of ways should prove helpful in developing the forest resources of the Americas."

MIDWAY PLANTS

Two Rare Varieties Found on Desolate Islands

At least two plants known nowhere else on earth are found on the remote, rather desolate Midway Islands, outpost of the Hawaiian archipelago, according to botanists of the Smithsonian Institution.

One of these is a variety of mint that once also formed part of the former luxuriant plant cover of Laysan—a small, uninhabited island about one third of the way between Midway and the Hawaiian Islands. About 1903 some rabbits accidentally were introduced on Laysan. In 10 years they had multiplied into thousands. They exterminated all the plants and reduced the island of less than two square miles to a sandy desert.

On Midway grows also a species of nightshade—of the nightshade-potato-tomato family. It is known elsewhere only on the small neighboring Ocean Island. The vegetation on both the Midway Islands—Sand and Eastern—is very poor. Only 20 kinds of native plants have been found there, the Smithsonian botanists say. The islands are among the most recent bits of the earth to emerge from the sea and afford an interesting example of the tendency of life to fill every possible spot and turn it into a suitable habitat.

Originally seeds of plants could have been brought there only in two ways—by ocean currents or by birds. The likelihood of wind-borne seeds traveling so far is remote. Yet plants have been able to establish a foothold there without human agency. They die and make soil, which provides a habitat for still more plants. Most of the plants are of kinds which spread through the Pacific islands.

Since the establishment of the cable station on Sand Island, several weeds and cultivated plants have been introduced—notably the oleander. The so-called San Francisco grass has also been brought in from the North American continent for the purpose of binding the sand, and various common weeds have come with soil brought in for gardens.

• • •

PAINT—The weather-resistance of a paint is approximately proportional to the angle that the grain of the wood makes with the surface: A wood surface with a vertical grain holds paint much better than wood with a slash-grained surface.

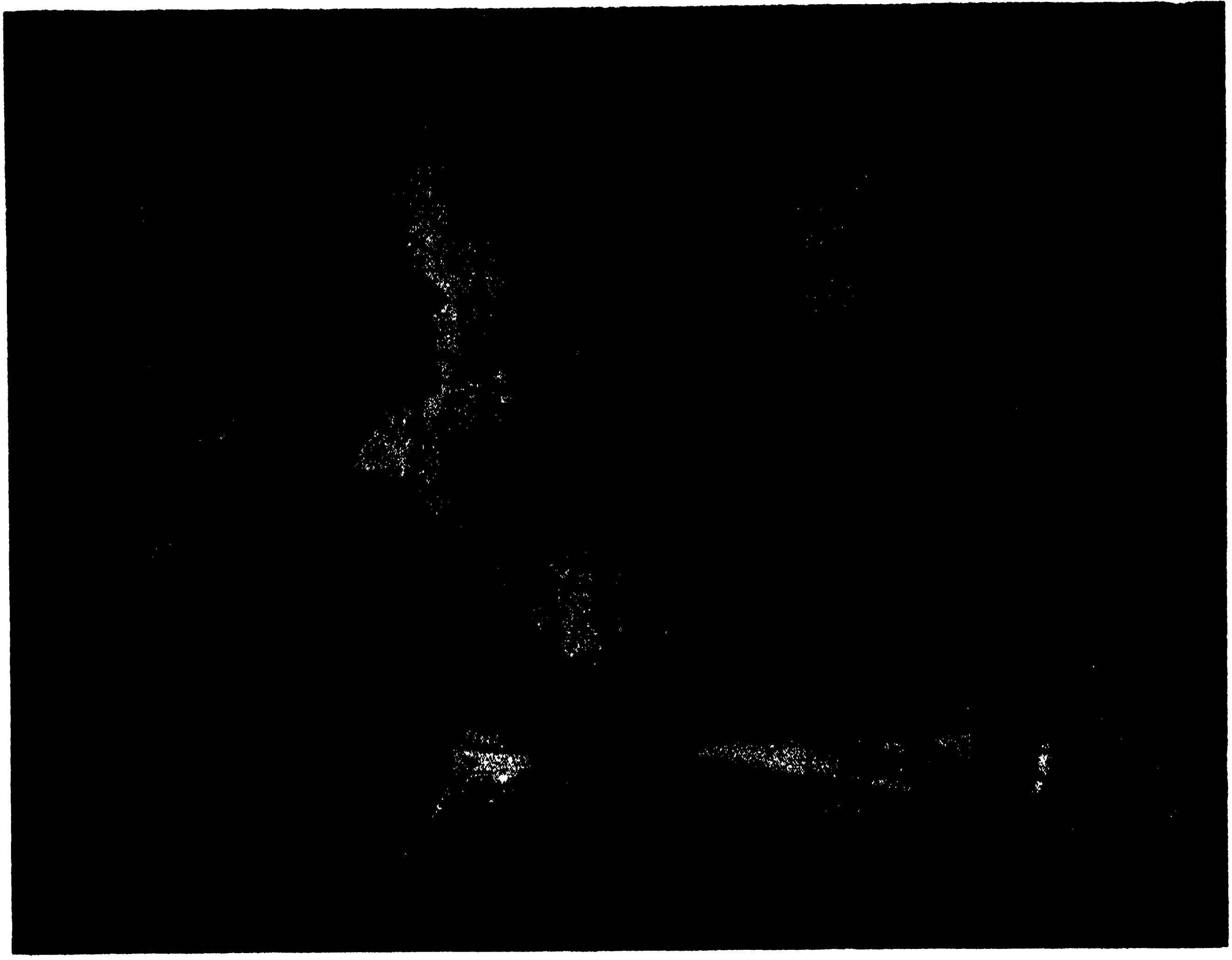
• • •

HOGS OR BEER?

Which Is the More Economical Source of Food?

The energy derived from eating meat is two removes from the original energy source—the sun. That is, the first remove is the vegetable which stores up solar energy, and the second is the animal which in turn stores up some, but only some, of this energy. This is why meat is a more expensive source of energy than vegetables and, incidentally, is why the crowded Chinese cannot afford to eat much meat. Now the British are arguing about the food value of beer. The following, from the *Journal of the American Medical Association*, states the crux of the argument about meat versus beer:

British opponents of the brewing industry, quick to take advantage of war conditions, have called attention to the fact that an appreciable percentage of all available English grain is now be-



How A Big Business Man Appears To His Wife

"LOOK at him over there, grinning to himself! Strange how little a man can change in fifteen years! The big boss one minute—and like a little boy the next!

"He was mostly 'little boy' before we were married. He'd been coming around for a couple of years, and I'd just about given him up. Then, suddenly, he was very much a *man*, rushed me off my feet and almost before I knew it, we were married.

"When we were newlyweds he was only a bookkeeper, and he'd come home in the evening all tired and discouraged. Other fellows at the office had been promoted, and he didn't know what to do about it. One night I forgot myself and said, 'If *you* don't do anything about it, Mr. Stick-in-the-Mud, no one else ever will!' Then I was sorry, when I saw how I'd hurt him.

"But it must have made him think hard, because one evening the following week he came home looking as though he'd just robbed the piggy bank. He told me he'd enrolled for a course of executive training. He thought I'd be angry, because we were still paying for the furniture. The 'little boy' and the man, all mixed up!

"After that, his whole point of view toward business seemed to change. One promotion followed another, until a few years later he became Treasurer of the company. Now he's beginning to surprise me. Says he expects to be Vice President soon!

"Of course, he's just as modest as he ever was. He'll tell you he got the breaks, but I know better. He *got* the breaks because he'd learned how to grasp them when they came. He's really smart—and so was I when I said 'I do' to a little boy turned man!"

• • •

What does the lady in *your* life think of *your* success? Get more of the Alexander Hamilton Institute's story in the famous little book, "Forging Ahead in Business." Tells how the Institute's timely training is helping thousands of men to do a better business job in these wartime days. Just clip and mail the coupon—today!

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ing used for the production of beer. They allege that this grain would be of greater social value if used for the raising of poultry or pigs. "Pigs versus beer" has thus become a current political slogan.

The brewers of England have countered by quoting experimental evidence previously published by nutritional experts of London University. Waller, for example, found that the food value of beer is more than half that of the grain and other material used in its production, while pig meat has less than one fifth the food value of the same materials if used in raising swine.

Moreover, 25 percent of the food value of the grain used in brewing is returned to the farmer in the form of brewers' grains, malt culms, or yeast, foods especially high in vitamin content and nutritive value if used in the animal industry.

The use of beer has also been under investigation by the food controller, who finds "no evidence that beer is doing anything to increase crime or bad health, or to reduce the output of munitions."

From such testimony it is officially concluded by the British cabinet that "it is in the public interest that the production of beer should continue at the present amount" (4 percent of all available grain).

UTILITY LANTERN

Combines Powerful Beam With Extension Light

A GENERAL utility electric lantern which has recently been developed features adjustable focus of the main light as well as an auxiliary light bulb on an extension cord that may be used to illuminate objects not reached by the larger beam. The plastic housing of this lantern is made of Tenite, is light in weight, and yet is so strong as to be virtually unbreakable.

Two-in-one lantern

Railway car inspectors, industrial plants, and servicemen are said to be rapidly adopting this lantern for general use.

BLACKOUT STRIPS

Prevent Light From Showing Around Shade Edges

AN ATTRACTIVE edging around window frames, which also acts as a track for the blackout window shade and, at the same time, prevents any light from escaping, is now available in the form of Tenite strips. These strips, which are produced in both black and white and which retain their high natural luster without the aid of polishing agents, offer a satisfactory solution to the problem of how to avoid cracks of light showing around the edges of blackout shades.

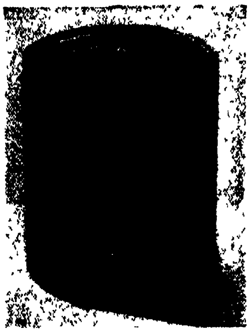
Light-trap window-frame edging

COLLAPSIBLE BARREL

For Bulk Materials, Saves Shipping Space

FOR the shipment of bulk material for which a container is required that can be later emptied and used again, a new collapsible unit offers features of strength and economy. As shown in two of our illustrations, these containers are made in the form of barrels than can be taken apart and shipped flat.

This collapsible container, placed on the market by Planters Manufacturing Company, consists of two plywood heads and two or more assemblies of plywood staves with provision at the ends to retain the heads. Secured to the staves are steel straps which terminate in eyes to take locking pins when the stave assemblies are wrapped around the heads. According to the purpose to which the container is to be put, the design may be such that adjacent edges of staves make tight or loose connection with each other, as may be desired Individual staves can be removed and replaced if broken.



Right: One of the new barrels made with plywood staves locked in place with steel straps. *Above:* One of the containers in collapsed form for re-shipment

OIL FROM COAL

New Method Being Checked In the United States

NEW research in the production of liquid motor fuels and lubricants from coal by a process not hitherto investigated in the United States, has been authorized in a recent appropriation by Congress to the Bureau of Mines. The Fischer-Tropsch method, developed and now industrially operating in Germany, has a number of advantages over the modified Bergius hydrogenation method which has been investigated by the Bureau for a number of years. Both methods start with coal, but the Fischer-Tropsch process gives a number of the separated fuel and lubricant products directly, while the output of the Bergius process is a single liquefied coal which is further treated much like crude oil in a regular refining process.

A further advantage of the new method is that much smaller plants are economically possible—about 30,000 tons a day against 150,000 tons a day for the Bergius process. This enables a wider and safer distribution of plants. Also, the Fischer-Tropsch process requires less precision machinery, and it can be used successfully with almost any type of coal, while certain coals with high ash content or extreme sensitivity to temperature variations present serious operating difficulties with the hydrogenation process.

Both processes produce about one ton (between 250 and 300 gallons) of liquid products from four to five tons of coal.

The experimentation in this country follows reports of the development of commercial processes for manufacturing synthetic fuels from coal in foreign countries, particularly in Germany. The Bergius process was introduced first, probably in a plant at Leuna in 1927, and the 13 known plants of this type at the end of 1940 are believed to have produced about 25,000,000 barrels of synthetic petroleum products a year. Fischer-Tropsch plants, the first of which was reported in 1936, accounted for about 11,000,000 barrels a year in 1940.

Experimentation by the Bureau of Mines assumes added importance because of the war, but basically is directed to obtaining all facts possible so that in the distant day when America may run out of petroleum, a rapid change-over to coal can be made.

• • •

TRANSPORTATION—For every passenger automobile available to carry war workers to their jobs in 1917, there are today six vehicles available.

• • •

"ELECTRIC ARMY"

Represented by Generators at Grand Coulee

THE equivalent of a new army of more than six and a half million husky workmen, laboring 40 hours per week, 50 weeks per year, went into action to speed production of war materials when the Bureau of Reclamation placed in service the third main generator at the Grand Coulee Dam power plant.

The big unit is capable of generating 108,000 kilowatts of electrical energy, 30 per cent more than any other hydroelectric generator except its two mates —an enormous output when it is considered that one kilowatt is equivalent to the physical output of 14 men laboring steadily.

The 946,000,000 kilowatt hours a year which the machine is capable of producing at full capacity will do work equivalent to that of 6,622,560 men laboring 40 hours per week, 50 weeks per year. On an efficient treadmill, such a gang would be able to lift 27,000 tons, almost the weight of a battleship, one mile straight up in an hour.

Figuratively speaking, one work crew of this size—Grand Coulee Dam's first generator—has been laboring on Uncle Sam's behalf since early in October, and a second has been in harness since late in January. Almost the entire output of the three units will be used to make aluminum when new production facilities, now under construction, are provided.

The throwing of the switch on the new machine marked the third time in about six months that the output of the big plant has been enlarged. In that short space of time, its capacity has been brought from a mere 20,000 kilowatts to 344,000, making Grand Coulee Dam, with only one-sixth of its generators in place, one of the largest hydro-electric power plants in the world.

The west powerhouse is scheduled to reach full development in 1944. Contracts have been awarded for six additional units, the first three to be installed in 1943. A powerhouse of similar capacity is being erected on the opposite bank of the Columbia, in the anticipation that more power will be required in the near future.

NOT SCIENTIFIC

Aversion to Non-Caucasian Blood is Emotional, not Factual

RECENTLY there has been agitation about alleged discrimination against Negroes, with regard to the use of

THE NEW NAVY "E"-with-star—awarded first to Bausch & Lomb—is official recognition of continued accomplishment in Production for Victory. It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make.

Dr. Braddock's Microscope Was Commissioned Today

DR. BRADDOCK wants a new microscope—a Bausch & Lomb Microscope . . . and he's going to get it. It won't be today, though, for today America commissioned a new cruiser.

On this ship there are many optical instruments with a myriad of optical parts, made by the same hands that, in other times, might be grinding the lenses for Dr. Braddock's microscope. There are range finders fore and aft, and a score of smaller ones in strategic places about the ship. The glasses with which the officers scan the horizon are Bausch & Lomb products. Yes, and there's a B&L Microscope, a duplicate of the one Dr. Braddock wants, in the laboratory of the ship's hospital.

Dr. Braddock still wants his microscope, but because he knows these things he is willing to wait. Thousands of "Dr. Braddocks" are making earlier victory possible.

Throughout the Bausch & Lomb plant, optical engineers and optical craftsmen are working long and tirelessly to further America's war effort. The lessons they are learning in the white heat of the drive for Victory will be available later to further the peacetime interests of science and industry.

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AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION

Impressively masculine is the appearance of Longines Watches for men. The enlarged photo shows Longines Coronation with diamond-set dial and 14K gold case at $175

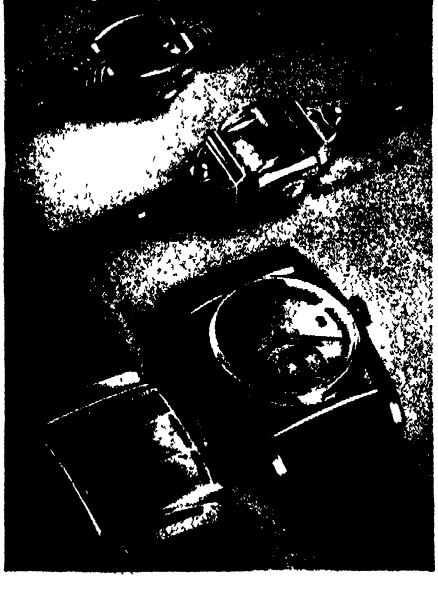
Longines

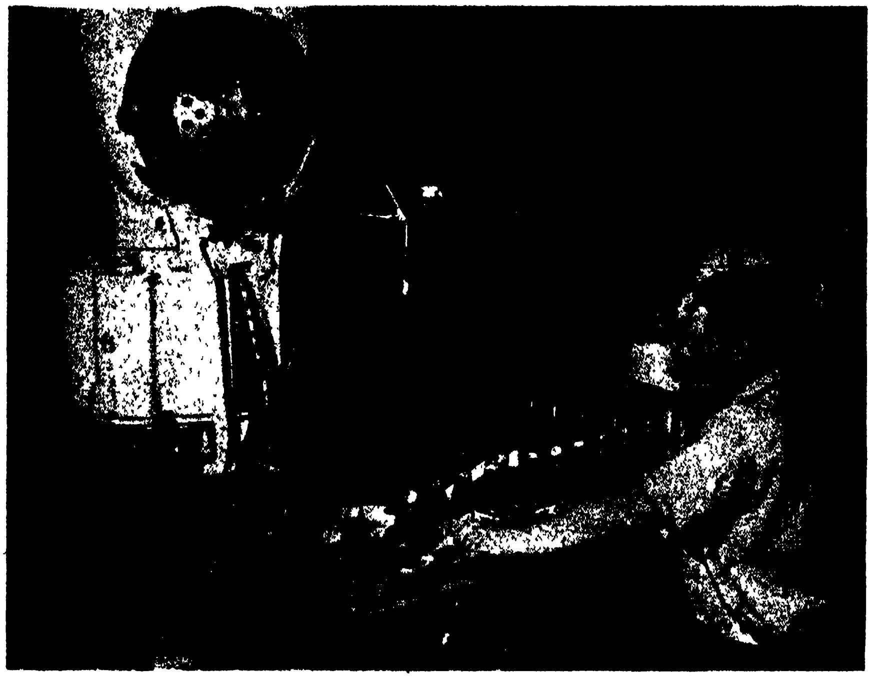
THE WORLD'S MOST HONORED WATCH

Longines provides watches in a wide variety of style but in a single variety of quality. Every Longines Watch is made to one standard that is world recognized for greater accuracy and long life, and time-tested by 76 years of use. The excellence and elegance of Longines Watches have won them 10 world's fair grand prizes, 28 gold medals and more honors for accuracy than any other timepiece. Longines-Wittnauer jewelers show the new Longines Watches; also Wittnauer Watches, a companion line of moderate price—product of Longines-Wittnauer Watch Company.

Prices Include Federal Tax

Longines Watches have won 10 world's fair grand prizes, 28 gold medals





Germ-killing rays emanate from over-head reflector

their blood for blood-banks for war purposes, and the question has been referred to the American Medical Association. The Association has stated, through its *Journal*, that there is no factual basis for such discrimination against the use of Negro blood or plasma for injection into white people.

Since syphilitic blood is eliminated from use for this purpose by thorough serologic testing, the rate of syphilis in Negroes is of no concern in this connection.

The transfusion of Negro blood into white persons and that of white persons into Negroes has been repeatedly performed in civil practice without any evidence of harm or aversion on the part of the recipients.

The present agitation arises from the inopportune publication of orders prohibiting the inclusion of Negro plasma in the military plasma bank.

The aversion perhaps represents the persistence of the ancient folklore that one's personality is closely associated with one's blood. Frequently used clichés, such as "noble blood," are remnants remaining in the language from a day when such superstitions were more prevalent than now.

GERM KILLING

Rays Used To Sterilize Bottles, Contents

SAFEGUARDING every manufacturing step of a soft drink, from the sterlization of the syrup to washing, filling, and capping of bottles, invisible ultra-violet radiations are being used to kill or inactivate more than 98 percent of all bacteria. One of our illustrations shows a hooded ultra-violet unit suspended over bottles about to be capped. At the Long Island City, New York, Pepsi-Cola plant 50 more of these Westinghouse Sterilamps are ranged around the top of a 1,500,000 gallon syrup tank.

• • •

PRESERVING—In spite of a long-clinging fallacy, the charring of wood to protect it from decay has no great preservative value when used alone. A modern treatment combines the charring of wooden poles to remove sap rot and spraying the charred areas with hot creosote.

• • •

FIBER PIPE

Supported by Concrete, Used In Illinois Oil Well

THE world's first oil well to be cased with fiber pipe and concrete as a substitute for steel is in successful operation in southern Illinois, and experts in the industry believe it is the beginning of increased oil production in all parts of the United States, especially in the shallow-well fields.

The experiment with fiber pipe cemented in the well as a substitute for steel in the well was conducted under the supervision of the Illinois State Geological Survey, where the idea of using fiber pipe originated. Based on official figures of well drillings, it is estimated that the substitution of fiber conduit for steel casing will save some 75,000 tons of steel during the next 12 months if drillings continue at the present 1942 rate. Should drillings reach the 1941 rate, a saving of some 150,000 tons of steel would result, according to this estimate.

According to the Fiber Conduit Company, the use of fiber pipe, supported by concrete, as oil-well casing is "a process which should prove to be of great value to the government, both as a means of saving much-needed steel and of increasing oil production."

TOO SOON

Anti-Aircraft Wires Invented During World War I

BRITAIN'S newest anti-aircraft weapon, a rocket that trails long tentacles of entangling wires, is no new thing under the sun. Its essential idea was proposed during World War I by Prof. R. W. Wood, noted Johns Hopkins University physicist, who was then overseas in war service. His idea was to have the wires spun out of an anti-aircraft shell. Ordnance men were interested in what they termed the "spaghetti shell," but the war ended before it could be developed to the field-test stage.

Since 1918 the general idea has persisted, and a number of inventors have had a go at it. Shells, rockets, balloons, and airplanes have been among the means proposed for getting the menacing steel tentacles into the air. It has also been proposed to string small bombs at intervals on the wires, to act like miniature mines when the aircraft struck them or pulled them into contact by winding up the wire on its propeller.

VEGETABLE FUEL

Being Used by Power Plants in Argentina

SUCCESSFUL conversion of steam-generating equipment in Argentine power plants now permits the burning of surplus vegetable fuels for power, according to the magazine *Power*. Use of shelled and cob corn, barley, bran, sorghum, seedcake, and sunflower seed husks, almost completely takes the place of imported coal and oil supplies now cut off by the war, the magazine states.

The converted plants are owned and operated by Argentine utility companies affiiliated with American and Foreign Power Co. The Calchines plant in Santa Fe has operated entirely on substitute fuels since the early part of this year. Shelled corn is burned on traveling-grate stokers, while bran is fed to forced-draft burners at the rear of the stokers.

A single large boiler at the summer seaside resort of Mar del Plata fires pulverized barley or bran. Corn on the cob, as well as sunflower-seed husks and shelled corn are burned at the Tablada station in Cordoba. Other plants at Tucuman, Mendoza, and Chivilcoy have been converted in a similar manner to utilize substitute fuels. Coal consumption has been completely eliminated in these stations and the quantity of fuel oil for boiler furnaces and Diesels has been materially reduced.

FERTILIZER

Magnesium Content Not Endangered

MAGNESIUM, one of the critical war metals, is also an essential fertilizer element on some soils, but there is no prospect of a shortage of magnesium for fertilizers, say Colin W. Whittaker and William M. Ross, of the United States Department of Agriculture, who have studied the supply situation.

Most soils have magnesium enough to supply the small quantity which plants require. Some magnesium, however, is a prime essential, since chlorophyll, the green coloring of the plant, includes this element. Lack of magnesium causes severe disorders in plants that can be remedied quickly and easily by supplying small quantities of soluble magnesium in fertilizers.

Before the war, the main source of the quickly soluble salt was calcined kieserite, imported mainly from Germany. With this supply cut off, fertilizer manufacturers turned to various forms of magnesium oxide, one of which is obtained by heating dolomite (magnesium limestone), of which the United States has abundant supplies. The heating changes the magnesium in

HOW TO GET THE MOST OUT OF YOUR LATHES

No. 1 *in a series of suggestions made by the South Bend Lathe Works in the interest of more efficient war production.*

Keep Your Lathes Clean

Yes, it's as simple as that. Keep your lathes clean and you increase production, reduce scrap, and lengthen the life of your equipment.

This will not only benefit you, but it will also be a definite contribution to our total war effort.

A small paint brush is convenient for brushing away dirt and chips

Dirt Is Abrasive

The scale, grit and fine chips produced by the cutting tool mix with the oil on the bed ways, dovetails and other bearing surfaces, forming a dirty sludge. Because this dirt is abrasive, it increases friction and causes wear wherever it is allowed to collect.

A small paint brush is convenient for brushing away loose dirt and chips. Compressed air is not so good because it may blow dirt and chips into oil holes and bearings. A clean cloth can be used, after brushing, to remove the last traces of dust and grit. A little oil on the cloth will prevent rust from forming on the finished surfaces.

The felt wipers on the ends of the saddle wings should be removed and cleaned in kerosene occasionally. An experienced machine tool service man should periodically inspect the lathe and remove any grit or chips that may have worked under the saddle or tailstock. The bed ways can be badly scored by a small steel chip imbedded in the saddle or tailstock base.

Don't Let Chips Collect

Adequate chip disposal should be provided to prevent chips from piling up underneath or around the lathe.

Now, when most machine tools are operating 24 hours a day, a small amount of carelessness may cause excessive wear — even a breakdown. Certainly an ounce of prevention is now worth far more than a pound of cure.

Write for Bulletin H1

Bulletin H1 giving more detailed information on the cleaning and care of the lathe will be supplied on request. Reprints of all advertisements in this series can also be furnished.

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the dolomite to a more soluble form. In areas where the problem is merely the prevention of a magnesium shortage, and not the need for a quick-acting remedy, the indications are that use of dolomite in mixed fertilizers or in liming fields will supply magnesium that will gradually become available.

Most of the supply of magnesium metal required in the war effort comes from other sources and war use does not affect the supply of agricultural magnesium.

DENTAL CHAIR

Is Fully Adjustable By Automatic Means

A DENTAL chair in which elevation and inclination of the patient are accomplished without moving the patient's mouth from the pre-determined and pre-focused illumination area, and without the necessity for the dentist to remove his hands from critical work at a crucial time to manually tilt chair and patient, has been developed by Dr. Richard W. Page, of Chappaqua, New York. Furthermore, by localization of the mouth area at a pre-determined point and by maintaining that position, the dentist is able to work entirely from a sitting position, thus avoiding the physical fatigue and foot discomfort which aggravate so many dentists. Likewise, cuspidor and rinsing cup at all times are more conveniently located for the patient and are reached by no more than a slight turn at the waist and a brief forward-leaning motion. This is in contrast to the former method of tilting the patient far back in the chair to obtain better operating conditions, a procedure which required the patient to pull himself erect in order to utilize the cup and cuspidor.

"If the operator is to assume the most convenient and restful positions while working," explains Dr. Page, "it becomes necessary in many operations to change either inclination or elevation of the chair, or both, one or more times. Most of these changes result in bringing the mouth out of the effective illumination area of even the best lights. This, in turn, places both patient and operator in awkward, uncomfortable positions in an effort to secure better lighting, or it requires the operator to use his hands to adjust chair and light, often at an inconvenient time and requiring re-sterilization of the hands."

In the dental chair shown in two of our photographs, changing the inclination or elevation is accomplished by foot controls. The patient can therefore be positioned in the most convenient manner, even though both of the operator's hands are occupied in the mouth; no matter how far above or below the patient it is desirable for the operator to be, the spotlight is always focused on the mouth and can, therefore, be mounted entirely out of the way of other essential accessories. The drill arm can be short and does not require constant adjustment to reach the patient in various positions.

The chair is recessed in the front section of the platform and is raised or lowered by means of the foot controls. Inclination is managed through use of rollers on tracks, motivated by an electric motor, also connected to the foot controls. The rear section of the platform, on which the operator's stool and the controls are

The spotlight (at top in both pictures) is always focused on the mouth, as indicated by the crosses in the two photos, regardless of how much this new dental chair is tilted mounted, can likewise be raised or lowered to place the operator at any level desired above or below the patient. The close-coupled operating range of the chair permits a more compact and pleasing location of accessories which, due to swivel arrangement of the stool, are always within easy reach of the operator.

CABLE GAS

Keeps Moisture Out, Sounds Automatic Alarm

What if a tiny pin-hole should open and let a tiny drop of water get inside a telephone cable? This cable is the protective metal sheath enclosing the fine copper wires, in some cases as many as 4242 of them. The answer is that even slight moisture might cause short circuits and service interruptions.

But such troubles rarely happen, usually only if a violent storm, explosion, or accident causes a cable break. The reason is that a vast part of the telephone cables of this country, carrying in all some 100 million miles of wire, are charged with dry nitrogen, a harmless gas, which is kept there under pressure.

Should a leak develop, the escaping gas keeps other moisture out. Moreover, instruments on the cable detect the drop in pressure, sound an alarm at a nearby station, and indicate the approximate location of the break A repair crew is quickly on its way.

BETTER GUN

Results from Use of Substitute Material

In making an important piece for a heavy machine gun, a former automobile maker produced a casting to replace steel tubing. The purpose, of course, was to effect a large saving of alloy steel in the manufacture of thousands of machine guns. But it was found that use of the "substitute" also greatly reduced the production time and resulted in a unit of higher quality.

With the approval of Army Ordnance engineers, a sample was cast, machined, and assembled into a gun for testing.

"I kept my fingers crossed when the Army inspector took the gun into the cold room and began whacking at it with a heavy steel bar," says the automotive factory manager in relating the story of the development. "I thought he was not being impartial when I saw him hit the standard unit only twice and then wallop our experimental gun eight times; but, after he came

EDISON STORAGE BATTERIES

Cells are in excellent condition. Complete with solution, connections and trays. Prices below are about 10% of regular market price. Average life 20 years. Two-year unconditional Guarantee.

A-4	Amp. Hrs. 150......Ea.	$6.00
A-6	Amp. Hrs. 225......Ea.	6.00
A-7	Amp. Hrs. 262......Ea.	7.00
A-8	Amp. Hrs. 300......Ea.	7.00
B-2(J-3)	Amp. Hrs. 37......Ea.	5.50
M-8	Amp. Hrs. 11......Ea.	2.00
L-20	Amp. Hrs. 13......Ea.	2.50
L-40	Amp. Hrs. 25......Pr.	4.00

All cells 1.2 volts each

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps or less an additional charge of 10% is to be added for trays.

U. S. ARMY TELEGRAPH SET

Signal Corps telegraph key and sounder mounted on mahogany board. Operates on 2 dry cells.................. $5.95

GLASS MERCURY TUBE SWITCHES

3 amp. .... $1.25 10 amp. $2.25
6 amp. .... 1.95 20 amp. 2.95

Lighting Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.

Price $225.00

Additional data on request.

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Hardwood, metric scale, 0-15 cm. and reverse, and log, scale hairline sight spirit level. 45° angle adj. type, made in France $1.95

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U. S. Army Engineers, Geologists, Surveying, Mapping, etc. Magnifying Eyepiece. $3.50

"Veeder-Root" Revolution Counter

Six number, (999999) non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special... $7.50

TRANSMITTING CONDENSERS MICA

operating volts 12,500, cap. 004.
Dubilier, new $12.50
Dubilier, used 10.00
Wireless Spec. new $10.00
Wireless Spec. used $7.50

Condenser, Dubilier, mica, op. volts 8,500, cap 004 ....$7 50

NICHROME WIRE
in stock
SIZES FROM #39 to .001

U. S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts. $2.95

Single Stroke Electric Gongs

Edwards 12" bronze DC 5 Ohm Mech. Wound $18.00
Edwards 10" bronze DC 5 Ohm Mech. Wound 15.00
Edwards 6" bronze DC 5 Ohm Mech. Wound 10.50
Schwarze 8" 100 Ohm 32 volt 10.50

Engineers U. S. Army Precision Type Tripods

Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ⅝" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips. Weight 5 lb.
Price $4.95

Build Your Own Searchlight
U. S. Army Parabolic Mirror
Precision Quality

Dia.	Focal Length	Glass Thickness	Price
11 in.	4 in.	¼ in.	$15.
60 in.	12½ in.	7/16 in.	75.
36 in.	18¾ in.	7/16 in.	125.

Made by Bausch & Lomb & Parsons. Perfectly ground and highly polished.

A few 60 in. slightly used metal mirrors on hand.

BAROGRAPH, FRIESE, 7 Day Graphic, 7 Jewel movement, 28 in. to 31 in. atmos. pressure by 20th. 8 Vacuum Cylinders 2⅝ in. dia. hinge cover, glass front, mahogany case. Price $55.00

U. S. Navy Divers Lantern

Electric 150 watt, any voltage, solid cast brass. 300 lb. test. Weight 12 lb.
Price $8.50

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric, Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate. Exceptional value $2.95

U. S. ARMY LIQUID COMPASS (Sperry)

Bronze jewel bearing. Leather case. 2⅝" diameter, 1¼" high $2.50

U. S. Army Engineers Prismatic Compass

Pocket type 360° Limited quantity. $10.50

HUTCHINSON PRISMATIC COMPASS

3 in. dia., brass, black enameled, improved pattern, with opening in top, floating jeweled dial 2 in. Each... $16.50

DYNAMOTORS D. C. to D. C.

24-750 volt. Gen. Electric 200 mills $27.50
24-1000 Gen. Elec. 1000 mills $50.00
12-350 volt 80 mills $15.00
12-750 volt 200 mills 30.00
32-350 volt 80 mills 9 00
32-300 volt 60 mills 7.50

Prisms, Binoculars, Bausch & Lomb, used, slightly chipped, 1 11/16 inch long by ¾ inch wide $2.00

United States Govt. Fire Extinguishers
(Refillable)
Heavy Copper & Bronze

Carbon tetrachloride (pyrene liquid), pressure type, ideal for labs, trucks, boats, garages, office, etc. (10 times more pressure than hand extinguishers.) Just turn handle. No pumping necessary. Ideal for remote control with wire. (Original cost $40 00.)

1 qt. (100 lbs. pressure).............$10.50
2 qts. (200 lbs. pressure)...........$16.50

TELEGRAPHIC TAPE RECORDER

Makes written record of code on paper tape. Ideal machine for learning code or teaching code to groups. Radio men can easily adapt it to short-wave receivers for taking permanent records of code messages. Double pen permits simultaneous recording of two messages. Pens operated by battery and key while tape feeder is spring driven. Made of solid brass on heavy iron base. Useful on fire, burglar alarm and watchman systems. May be used to intercept telephone dial calls. 10 ohms.
Rebuilt & finished, like new $47.50 Reconditioned $30.

MANHATTAN ELECTRICAL BARGAIN HOUSE, INC., Dept. S.S., 120 Chambers St., New York City

Plan for "Duration" Living

NO SERVANT PROBLEM
NO TRANSPORTATION PROBLEM
NO OWNERSHIP PROBLEM

SCALED TO REDUCE COSTS, INCLUDING, IMPORTANTLY, COST OF MEALS

The Waldorf offers its "flexible-living" plan for 1942 on three different schedules:

ASTORIA APARTMENTS...one-room apartments that "live" like three rooms...for restricted budgets.

WALDORF ROOMS...large, homelike rooms and distinctive suites for individual or family living.

THE TOWERS...distinguished apartment-homes... 2 to 8 rooms...complete privacy...service pantries.

Astoria Apartments, Waldorf Rooms and homes in The Towers are serviced by The Waldorf's skilled staff...including many tried-and-true employees from the original Waldorf. Concrete and steel, The Waldorf is one of the staunchest buildings in New York. On guard day and night are trusted employees, all U. S. citizens...all bonded.

BOOKLET ON REQUEST

THE WALDORF-ASTORIA

PARK AVENUE · 49TH TO 50TH · NEW YORK

out of the cold room, he explained that the second blow had buckled the regular unit and that our cast substitute had come through undamaged."

Having won official approval, the substitution has effected larger savings of time and material than even its original proponents estimated.

The section of tubing which was replaced had weighed 20 pounds in the rough, and was whittled down in a series of machine operations which reduced it to a thin cylinder, pierced with many holes, and weighing less than five pounds.

In other words, manufacture of the part, as originally specified, required handling, machining, scrapping, transporting, and re-melting of three quarters of the steel in the original piece. Refinement of the casting, on the other hand, sends only 1½ pounds of steel into the salvage bin. The reduction in man-hours required for machining alone is more than 45 percent. —*Automotive War Production.*

• • •

PLYWOOD—For appearance or economy, plywood panels are sometimes constructed with faces of one kind of wood and backs of another: For example, they may have a birch face for appearance, the rest of the plies of Douglas Fir.

• • •

PARACHUTE BOAT

Carries Much Equipment, Yet Is Light In Weight

A NEW one-man parachute boat for emergency use on single-seater fighter planes has a total weight, including the 11 items of vital equipment that help protect the flier, of only twelve pounds. The boat is attached to the pilot as a seat pack when he is in the plane, is held tightly to him in parachute descent, and can be inflated in from five to ten seconds by turning a valve on a small CO_2 cylinder. First shipments of the new type boat have already been made by United States Rubber Company.

Advantages of the one-man parachute boat for speedy, small fighter planes are its light weight, great compactness and the fact that the boat always stays attached to the pilot.

Although this orange-yellow boat is 5 ft. 6 in. long by 3 ft. 4 in. wide when inflated, it folds into a compact seat pack only 14 by 15 by 4 in. Within this package is a full set of vital equipment. Two wire-reinforced fabric paddles fit the hands of the flier and are used to propel and steer the boat. A concertina hand pump is fastened to the inflation valve and can be used for maintaining required pressure.

The action of the pump, shown in use on our front cover, is similar to that employed when playing an accordion.

In case the boat should be pierced by machine-gun fire, the equipment includes special plugs the flier can quickly fasten into the holes made by bullets. If any accident should happen to the boat he has equipment for emergency use which he can use either working from within the boat or from in the water. In addition, he has a collapsible fabric bailing cup and a collapsible fabric sea anchor.

Total weight is only 12 pounds. In addition, the Government furnishes a can of water, and a sea marker for use by the flier in drawing attention for rescue purposes.

This new one-man parachute boat includes innovations developed by Fred Patten, boat expert of United States Rubber Company, working with basic British designs.

PHONOGRAPH FILTERS

Serve to Reduce Needle Scratch, Equalize Tone Values

USERS of electrical phonographs, either complete in themselves or attachments to radio receiver amplifiers, will find interest in two new devices recently designed to improve the playing qualities of such equipment. These units, one of them fixed and the other adjustable, are designed to be used with either magnetic or crystal pickups and to reduce to a minimum any annoying and unnecessary needle scratch Furthermore, they can be used to alter the tonal range of the reproduction.

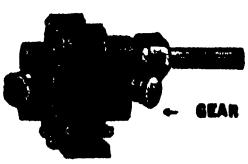
Needle scratch control is accomplished through the use of tuned filter circuits which by-pass the objectionable high-frequency noises from the amplifier circuit to the ground, leaving only the desired musical tones

By means of other tuned circuits, control is exercised over the tone of reproduction. In the non-adjustable model of these units, manufactured by Gold Shield Products, tone equalization is obtained by switching connections to the proper binding posts. In this way, bass notes may be emphasized, or high fidelity reproduction may be obtained. In the adjustable model the needle scratch filter operates in the same manner as in the fixed unit, but the frequency response characteristics of any record may be varied at will by means of a special control knob.

The method of connecting either of these devices to any type of electrical phonograph is extremely simple and, the manufacturers state, anyone who can tune in a radio set can install and use one of them.

IMMEDIATE DELIVERY
LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

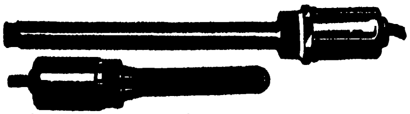
BRONZE GEAR AND CENTRIFUGAL PUMPS



	Inlet	Outlet	Price	With A. C. motor
No. 1 Centrifugal	½"	½"	$ 6.50	$25.00
No. 4 "	¾"	½"	12.50	32.00
No. 8 "	1¼"	1 "	16.50	35.00

No. 1½	Gear	⅛"	Price $ 9.00	With A.C. motor	$25.00
No. 2	"	¼"	" 10.00	" " "	27.50
No. 3	"	⅜"	" 11.50	" " "	28.50
No. 4	"	½"	" 12.50	" " "	32.00
No. 7	"	¾"	" 15.00	" " "	37.50
No. 9	"	1 "	" 16.50	" " "	49.50
No. 11	"	1¼"	" 42.50	" " "	on request

General Electric Immersion Heaters



Suitable for heating liquids tanks, kettles, etc. (1 KW raises temperature 100° F 3 gallons per hour.) Fitted for 1½" iron pipe thread. Can be used as 110, 220 volt or 3 heat 110 volt.

600 Watt.........$7.50 1200 Watt $10.50
750 " .... 7.50 2000 " 12.50
3000 Watt $15.00

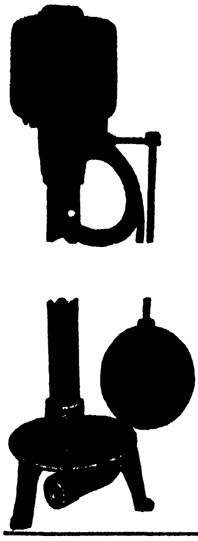
DURAKOOL MERCURY SWITCHES

This metal mercury switch overcomes faults of usual mercury switches. May be turned a full 360°. Has thousands of known applications from tiny lab instruments to gigantic power controls.

1 Amp. ....$1.10 20 Amp. $3.15
3 Amp. .... 1.65 35 Amp. 5.50
6 Amp. .... 1.65 65 Amp. 11.00
10 Amp. .... 2.00 200 Amp. 50.00

COROZONE OZONATOR

An electrical device that converts ordinary oxygen into ozone. Revitalizes and deodorizes the air. Suitable for laboratory, factory, office or home. 110 volt AC. Only 10 watts. $9.50



AUTOMATIC CELLAR DRAINER

Prepare for rainy season. Keep your basement dry at all times New improved Oberdorfer sump pump.

Pump built entirely of bronze, rust proof, long life.

Has Thermal Overload Device. Positively dependable and protects motor in case pump stalls.

Capacity 3,000 gallons per hour with ¼ h p motor at low operating cost

Model B-2400 unit complete with 110 v. 60 cycle motor. $37.50

Unconditionally Guaranteed for One Year.

Literature Sent on Request

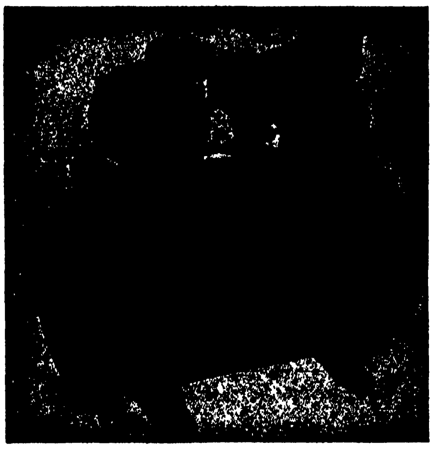
Small Piston Type Air Pump

Can be used for all purposes where low pressure air is required. Develops 1/3 cu. ft. of air at 15 lbs. pressure. Suitable for aquariums. Takes care of 6 to 8 tanks. Piston type, all brass cylinder. Belt driven. Universal AC-DC motor. Mounted on neat base. Complete. $7.95

EXHAUST FANS, BUCKET BLADES
General Electric A.C. 110 volt motors.

	R.P.M.	cu. ft. per min.	Price
9"	1550	550	$12.00
10"	1500	550	13.50
12"	1750	800	18.00
16"	1750	1800	21.00
16"	1140	1650	27.50
18"	1750	2500	22.50
18"	1140	2100	32.00
20"	1140	2800	36.00
24"	1140	4000	42.00
24"	850	3800	45.00

Other voltages & frequencies available at slightly higher prices



HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

Models D H G ¼

12" x 24" tank A.C. 110 or 220 v. 60 cycle $57.50

16" x 30" tank A.C. 110 or 220 v. 60 cycle $64.50

Large stock of air compressors, ¼ H.P. to 20 H.P. A.C. and D.C., all voltages, 1 to 120 C.F.M. displacement, built for all requirements. Additional data on request.

FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H.P.	R.P.M.	CU. FT. MIN.	INLET	OUTLET	PRICE
0	1/20	1750	100	4½"	3¼"	$22.00
0½	⅛	1750	350	6½"	3½"	25.00
1	1/6	1750	535	6 "	4½"	30.00
1¼	¼	1750	950	7½"	6 "	37.50
1½	½	1750	1900	9½"	7 "	75.00

PRICES QUOTED ARE FOR A.C. 110 V. 60 CYCLES ONLY.
OTHER VOLTAGES ON REQUEST.

PIONEER AIR COMPRESSOR CO., Inc.
120-s CHAMBERS ST. NEW YORK CITY, N. Y.

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Take first step, without cost, toward protecting your invention. Write today for free RECORD OF INVENTION form to legally disclose your invention. We also send Free 48-page PATENT GUIDE containing instructions on how to patent and sell inventions; details of search services; easy payment plan; other interesting facts
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and HARVEY B. JACOBSON
24-K Adams Bldg., Washington, D. C.
REGISTERED PATENT ATTORNEYS

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Not a machine — BUT — a new theory of Mathematics — the greatest improvement in Arithmetic since the beginning of time. Solves all figure problems in 1/10 usual time and 1/10 usual effort. Infallible for accuracy and unequalled for speed. Postpaid $1.00 — Worth a hundred. Arith-Magic, Dept. 18, Maywood, Illinois.

Army Haversacks
heavy canvas, 7½ by 11 inches, with pockets, second hand, with leather sling. Postpaid for 75 cents. 1940 75th Anniversary catalog, 308 pages, 2000 illustrations, mailed for 50 cents.
1942 circular for 3c stamp.
Francis Bannerman Sons
501 Broadway, N. Y.

SMITH & WESSON
The World's
Finest Revolvers
Since 1854

ALNICO MAGNETS
1" x ⅜" x 3/16" 2 for 50c
2¼" x ⅜" x ½" BARS 2 for $1.50
LIFTERS — $2.00 — $3.00 — $4.00
BLAN, 64-V3, Dey St., New York

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COUNTERS
for Every Purpose
MECHANICAL ELECTRICAL
MANUAL
VEEDER-ROOT Inc., Hartford, Connecticut

The Morse Decimalizer
The DECIMALIZER shows in a few simple manipulations just where to place the decimal point in the result of any computation involving several elements, part or all of which may be decimals— for example, in such a problem as (9 x .0432 x 74 1 x 3.8) ÷ (245 x .0093 x 36). The DECIMALIZER removes that "decimal point hazard" inherent in computations made with the slide rule or otherwise.
Pocket size; durable (stainless steel); exceedingly smooth in action. Furnished in leather case, with complete directions for using. Price $2, postpaid; with extra, easily interchangeable scale which enables the instrument to perform extended multiplication and division, 50 cents additional. Money back, if returned within 10 days.
GEORGE H. MORSE
[illegible] Street South Arlington, Va.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

DESTRUCTION TEST

Simplified by New Vibrating Equipment

DESIGNED for use in aircraft and industrial plants where there exists a need for testing products under conditions of vibration, a newly designed test table can be applied to determining the vibration resistance of a wide range of instruments, carburetors, control units of many types, and so on.

Variable vibrations

When the apparatus shown in one of our photographs is to be used in testing, the instrument or other equipment to be tested is firmly clamped to the six-inch square table. The drive will then impart vibration to the table in a vertical plane at variable speeds from 600 to 3600 cycles per minute over an amplitude range variable from zero to one-fourth inch. Both of these ranges are completely adjustable. It is claimed that the equipment will handle test work up to ten pounds maximum weight. Developed by Televiso Products Company, this testing device operates on 110-volt 60-cycle A.C.

THROW-AWAYS

Made of Plastic, Release Important Machinery

SCREW plugs, dummy plugs, cap plugs, and other devices are often used for the protection of hollow equipment or other articles from dirt, dust, and moisture while being handled or in transit. These plugs, commonly known as "throw-aways," have no functional value after the shipment reaches its destination. Formerly made of metal, and requiring the use of screw-machines, die-casting equipment, and other needed tools, these "throw-aways" are now being produced by American Molded Products Company from a tough plastic, thus releasing metal-working machinery for other and more important work.

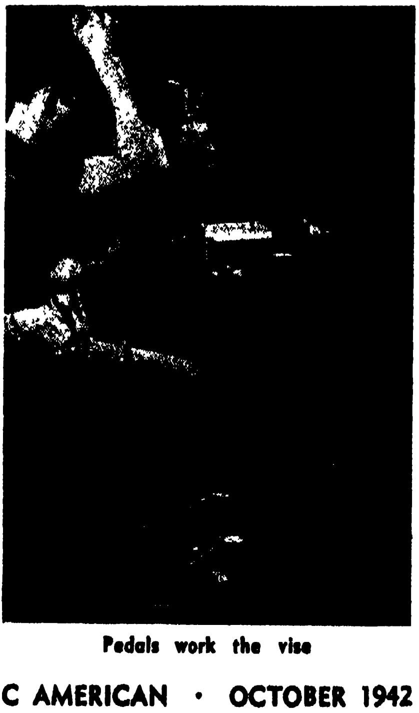
DRILL VISE

Operated Hydraulically by Pressure on Pedals

A NEW vise for use by tool and die makers, machinists and machine operators, and designed for holding work on the table of all types of drill presses, planers, shapers, milling machines, surface grinders, lathes, cut-off saws, and other machines, is called the Drilvise by its makers, the Studebaker Machine Company.

Entirely foot controlled and hydraulically operated, this new tool permits the use of both hands in the operation, set-up, and removal of work from the machine on which it is mounted. Exerting in excess of 10,000 pounds per square inch pressure between the jaws, this unit is ideally adapted for hundreds of machine shop uses.

Self-contained, requiring no outside power or air supply, the unit consists of a conventionally-shaped drill press vise (but without the usual screw or



Pedals work the vise

handle) and, connected to it by a six-foot length of flexible rubber tubing, a hydraulic foot control base. Parts are readily portable and can be easily moved from machine to machine.

Work is placed between the open jaws of the vise, the operator moving the rear jaw toward the stationary front jaw by depressing the middle pedal of the foot control. This operation, taking only a second, moves the rear jaw against the work, exerting just the right amount of pressure to only grip the work. The right or booster pedal moves the jaw a maximum of 3/16" for each downward stroke of the foot and exerts a maximum non-slipping pressure of 10,000 pounds per square inch. To release work held between the jaws, the left pedal is depressed with one downward movement of the foot.

TURRET LATHE

Adaptable To Many Precision Jobs

A NEW bench model turret lathe for rapid production to close tolerances on chucking operations of bar works has just been announced by the South Bend Lathe Works. This lathe has a 10-inch swing over the bed and saddle wings, 1⅜-inch hole through the headstock spindle, and one-inch collet capacity. It is well adapted to second operation work.

The hand-lever operated bed turret indexes automatically and has an adjustable stop for each of the six turret faces. The lathe is equipped with both a compound rest cross slide and a hand-lever cross slide, which are interchangeable. The latter is furnished with front and rear tool blocks which provide three tool positions. A quick-change gear box supplies 48 longitudinal power feeds for the universal carriage, 48 power cross feeds for the compound rest cross slide and 48 thread-cutting feeds, 4 to 224 per inch. The underneath motor drive and back gears deliver 12 spindle speeds, from 97 to 700 revolutions per minute.

Ten-inch swing

LEVEL

Has Circular Bubble Which Accurately Shows Deviations

A NEW and compact level with which deviations in both longitudinal and lateral directions may be read on one setting has recently been announced by the William P. Fell Company.

Square scale shows deviations

The new unit, with a bearing surface 3½ by 6 inches, contains a gage glass 2⅜ inches in diameter. The indicating bubble, 1 5/16 inches in diameter, floats inside square graduation lines so spaced as to represent .0005 of an inch per foot of deviation from level.

RUBBER SUBSTITUTE

Made Practical by Use of Synthetic Wax

IN replacing rubber as a cloth backing in the manufacture of raincoats, life belts, and so on, the plastic material polyvinyl butyral has been used with considerable success. However, the characteristic surface tack of this material has to be eliminated without, of course, adversely affecting the other properties. It has been found that Acrawax C, a synthetic wax manufactured by the Glyco Products Company, Inc., when added to the polyvinyl butyral in amounts as low as 1 percent, effectively eliminates this surface tack. Furthermore, Acrawax C is a high melting point wax (275-280 degrees, Fahrenheit), non-brittle, water insoluble, and non-greasy. One percent is completely compatible with the plastic and shows no signs of blooming to the surface. It is available in powdered form and therefore can be readily incorporated with the other compounding ingredients in the milling operation.

1917 WAR RUN BY TELE-PHONE
1942 WAR RUN BY RADIO

For Instance...

...during the battle of Midway the men in the radio room of an American aircraft carrier got a chuckle. They overheard two very excited Japanese talking—and they didn't sound happy... (news item)

... there were 81 enemy bombers—swarms of fighters above and below... ... when they were spotted the call went out over the radio— ... the Marines piled into them. (news item)

Interesting!

Watch for radio use in the war news — you'll find it in the air — on the ground — and at home!

WITHOUT radio, the movement of war would still be anchored by telephone lines—the physical hazards of the courier and visual signals.

Now war moves swiftly over the whole face of the earth—instantaneous radio communication thru the ether instead of over copper wires has blasted the barriers of space and time.

So today all our radio production centers on war use.

But what of tomorrow—what effect will this have upon the future—after victory?

One thing is certain—it will revolutionize and speed the great new future form of transportation. •

Radio has never been universally necessary in transportation before. In automobiles—on trains—it has been entertainment—in boats it has been a great aid but not an essential.

But today for the future, in that great, new universal transportation that is forming itself—the airplane—radio is essential as the engine itself.

And—mark this well—airplanes and radio are two of the four *great* industries destined to lead this country back to business normalcy after the peace is won.

Zenith's leadership in the radio industry has been established by a constant achievement of "firsts." Repeatedly, ideas "brand new" when Zenith "first" introduced them, later became essentials on all radios. And that same "forward thinking" of engineers and factory and organization now concentrates on war production of the thing we know—radio—exclusively radio. We are progressing—we learn every day—and this new experience will inevitably reflect itself when Zenith again produces for peace.

—a Zenith Radio Dealer near you is giving reliable service on all radios—regardless of make.

ZENITH RADIO CORPORATION—CHICAGO

ZENITH RADIO
RADIO PRODUCTS EXCLUSIVELY
WORLD'S LEADING MANUFACTURER

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"CYCLOPEDIA
OF FORMULAS"

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24 West 40th St., New York, N. Y.

The Mighty Mars

Huge Cargo Planes Will Play a Leading Role in After-the-War World Economic Developments

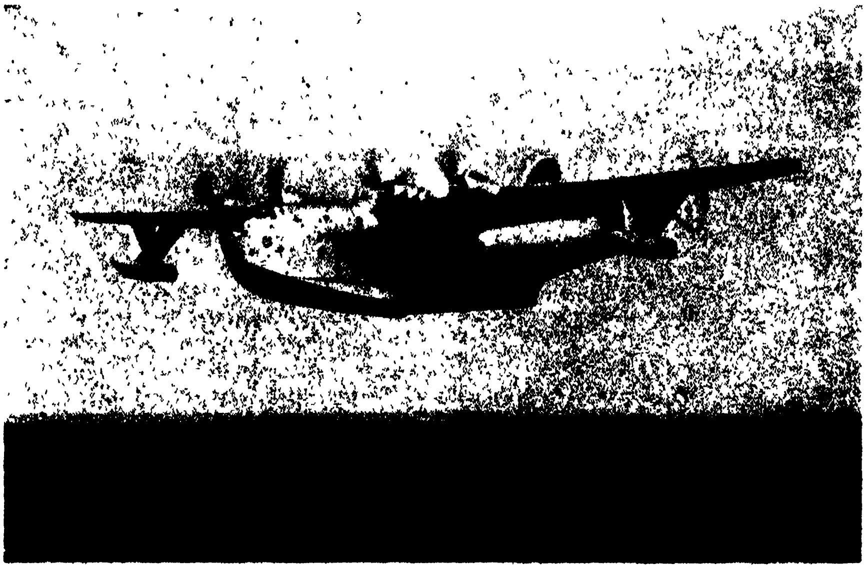
ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

To anyone who follows the press, the hearings before the Senate Committees investigating the possibility of our building huge cargo planes must be of considerable interest. We shall not enter into the argument nor attempt to analyze the statements of such authorities as Grover Loening, Eddie Rickenbacker, Henry J. Kaiser, and others. It is a very tempting idea to provide huge cargo aircraft, which will fly large loads rapidly to the outermost ends of the earth in a fraction of the time required by slow surface vessels, but there are two points on the other side. How quickly can we build such giant aircraft, and will the engines and other materials diverted to this task delay the construction of bombers and other fighting planes?

We are, however, able to present to our readers some preliminary information on the Mars, the huge new flying boat built by the Glenn L. Martin Company, prototypes of which are now under discussion for mass production. The Mars has recently made its first official flights, on behalf of the United States Navy, over the Chesapeake with complete success. With a wing span of 200 feet and a gross hull displacement of 995,000 pounds, the Mars could fly non-stop to Europe and back. Although rated as a patrol bomber, she can carry a large cargo, or, as a troop transport, 150 armed men. With such load-carrying capacities the proponents of the plan of building comparable boats in large numbers have some real ammunition with which to fight their battle.

The Mars is huge in every proportion. The cubic content of the hull is roughly that of a 15-room house. The crew can walk in the center portion of the wing to service the engines in flight. The four Wright Cyclone engines develop 2000 horsepower each and swing propellers 17½ feet in diameter. There is a spacious wardroom for officers and recreation space for the crew. The Commanding Officer has his own desk on the bridge and his own private stateroom. He can pace the bridge in flight in true sea-going fashion. There are two full decks throughout, a telephone exchange with 24 stations. Life aboard the Mars will be like life on a naval warship. The maximum normal weight of the ship will be 140,000 pounds, and the length overall is 117 feet, 3 inches. The height to the top of the hull is 24 feet. Sleeping accommodations will be available for 13 men. The gasoline capacity is enormous.

In one of our photographs the huge boat is in flight. The first impression



In its magnitude, a possible fore-runner of planes to come we get is how closely the giant hull approaches the most desirable aerodynamic characteristics. The size of the hull is so vast that the landing step becomes almost insignificant. In the Boeing Ranger, another development in plane design, the tip float is mounted on a single cantilever strut; here we see two struts disposed at an angle providing for the bracing. The cockpit, or navigation room, blends beautifully into the rest of the hull. Twin rudders are employed. The rear portion of the hull rises cleanly upwards so that the tail surfaces are far from the water at all times. Tremendous skill and millions of engineering and shop hours go into the construction of the prototype of such a flying boat. Whether the Mars should be built now for war use is not for us to say. But we will go definitely on record that after the war such huge flying boats will make the Queen Elizabeth and the Normandie obsolete so far as first class over-ocean passengers and mail are concerned. Even as regards freight, the new seaplanes of this size will give surface vessels some stiff competition. It is not surprising that American Export Steamship Company has gone into the air transport business over the Atlantic, and that the Chairman of the Cunard Company, addressing his stockholders, speaks of his company giving consideration to the operation of flying boats after victory has been attained.

PLANE RANGE

Increase is Desirable for Pursuit Ships

Our bombers are the best in the world and wherever they appear we stand a fair chance of aerial supremacy. Moreover, our bombers have long range and can proceed under their own power to almost any quarter of the globe where they may be needed. The problem of delivery of the pursuit planes which may be needed to accompany the bombers, however, is not so easy, and a number of suggestions have been made for increasing their range.

One of these suggestions is to build a convertible monoplane-biplane. The biplane could carry a greater gasoline load than the monoplane, and the wings would be folded back into the fuselage when there was fighting to be done. Another suggestion is to use a biplane at the start and allow one of the wings to drop off when its duty had been done. Still another is to use an external gasoline tank of streamline form, to be jettisoned when the fuel in the tank had been exhausted. It is this last idea which is illustrated in the reproduced photograph of the Army Bell P-39 D *Airacobra.* The only change over the earlier production type is in the addition of the "belly tank."

The Airacobra carries a heavy cannon and is powered by an Allison V-type liquid-cooled engine, submerged behind the pilot's compartment. It is connected to the hollow-hub propeller by a 10-foot drive shaft. It will be noted that the Bell fighter is equipped with a retractable nose wheel, and a movable canopy for the cockpit to the left in the photograph.—*A.K.*

One of several suggestions for increasing flying range: "belly tank"

JAP ENGINES

Analysis of Mitsubishi Kinsei Motor

Our friends frequently ask whether Japanese planes and engines are really good. Mr. W. G. Ovens, of Wright Aeronautical, answers the question in a paper published in the *S.A.E. Journal,* entitled "Some Notes on Design Features of the Mitsubishi Kinsei Engine." This is a two-row engine of 14 cylinders, with a take-off power of 1050 H.P., apparently fairly comparable to one of our own engines and in excellent condition before it crashed. Mr. Ovens drew the following conclusions:

"'The engine is undoubtedly a highly dependable, even though not highly developed, piece of equipment, probably produced under time and tooling limitations which we would consider nearly impossible.'

"The designers 'did a very ingenious job of combining what they apparently believed to be the most desirable features of a number of foreign engines—proved features all—into a composite design that "has to work the first time," and probably did.'"

That certainly answers our friends' questions so far as engines are concerned.—A. K.

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How Black Is Black?

WE say that a black surface absorbs light, although we do admit that certain black surfaces absorb more light than others. However, it is not too generally appreciated that it is not alone the tone of the black that we have to consider in this connection, but in addition its texture or *lack of texture*—whether its surface is matt or glossy. A smooth black surface, regardless of its reflective capacity as compared with a textured surface, will reflect light as strongly under certain circumstances as if the surface were not black but were some gray tone. These circumstances involve three factors—gloss, direction of the incident light, and viewing angle.

Remember the rule that the angle of the incident light (the light source) is equal to the angle of reflection? A black surface will appear almost white if it is smooth, glossy, and the angle of the camera to the black surface is equal to the angle of the incident light. Changing the angle of the light source or that of the camera will minimize the reflection and substituting, where possible, a textured, matt surface for the smooth, glossy one, will break up the partnership even more effectively.

Better Than the Whole

ISOLATE a detail suggestive of the entire scene, and you often get a more impressive picture. This is particularly useful in a situation such as that illustrated. Folk dancers entertaining an outdoor audience had to be shot against a background of such distractions as those seen in one of the illustrations, or not at all. The composition was good, but the effect was greatly diminished by the busy background. A closer viewpoint produced the other picture, in which the distractions are largely eliminated by the rather drastic expedient of "eliminating" parts of the subjects as well! However, this major operation seemed appropriate to the photographer in this instance, for interest was focused chiefly on the leg movements. For when skirts fly and legs are revealed, where do *you* look? So do we!

Prints for the Service

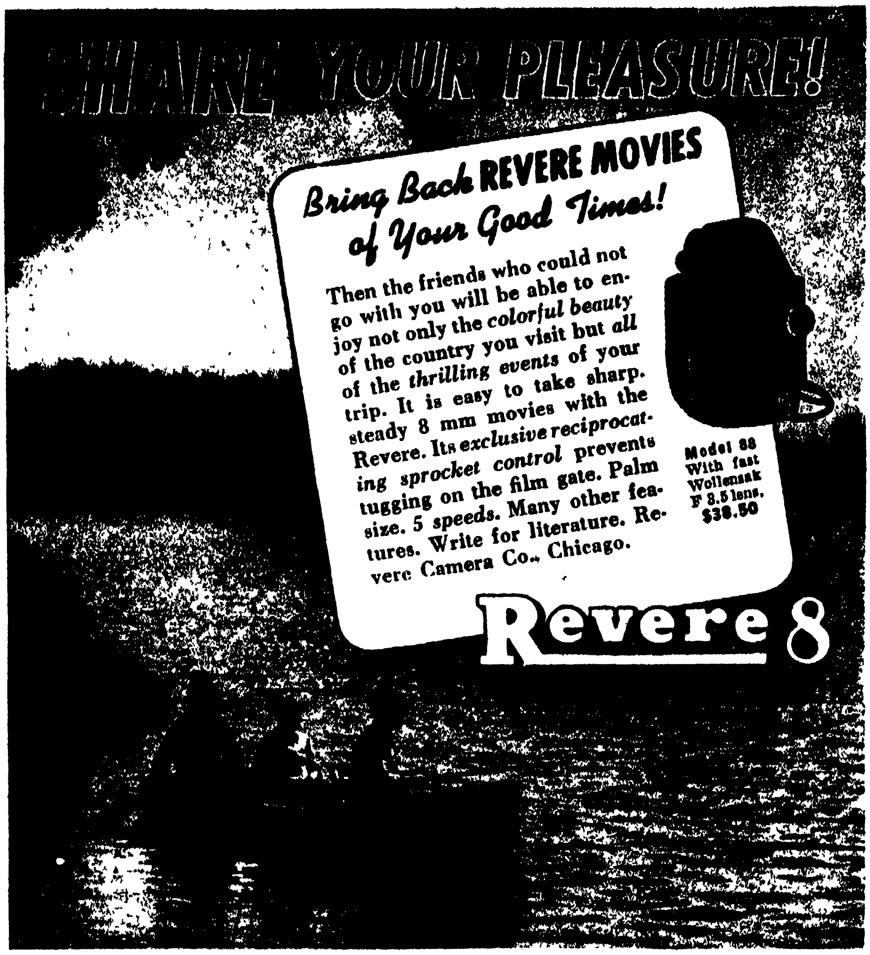
WITH a couple of thousand prints already on display in 16 or more Army and Navy posts in the Third Corps Area and overseas Atlantic bases, the

Distractions eliminated

"The effect was greatly diminished by the busy background . . ."

Photographic Division of the Citizens Committee for the Army and Navy, Inc., is now in full sway. The shows, which are displayed in the day and recreation rooms of the posts, vary from 25 to 350 prints and enjoy not only the approval of morale officers but their active support as well.

Prints are solicited from the ranks of both the amateur and the professional, the best ones selected, and shows assembled to furnish representative salons of the finest work available in this country. In addition, the committee has assumed the responsibility of supplying the camps with the necessary hanging facilities. Members of the exhibit committee serve without remuneration and the funds required to defray the cost of display materials are contributed by individuals and groups. The presentations, which will continue for the duration, got off to a full start recently with a showing of 300 prints at Fort Hamilton



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Dustless Negatives

Contrary to popular belief, Augustus Wolfman says that a camel's-hair brush or a soft cloth are *not* the proper mediums for removing dust from negatives before enlarging. "While either of these items will brush the dust off the negative, they induce a static charge of electricity in the negative which attracts more dust, like a magnet attracts steel," he asserts. Moving the finger lightly across the film or blowing lightly will clear the surface of dust without "charging" the negative, he advises.

He suggests further that in removing fingerprints and grease marks from negatives, it is wrong to use carbon tetrachloride, as this, being a "dry" cleaner, has the same effect as using a camel's-hair brush. He therefore recommends the following "wet" cleaner as being most effective:

Film Cleaner	
Ethyl Alcohol (pure grain alcohol)	85%
Methyl Alcohol (wood alcohol)	10%
Strong Ammonia Water ...	5%

Tinted Movies

Movie makers shooting black-and-white film have occasionally adopted the practice of placing a filter on the projection lens to obtain "color" movies. This method receives the stature of an accepted procedure with the introduction commercially of a set of four monochrome projection filters, "blue for snow and sea scenes, red glow for sunsets, green for masses of forest and lawns, mellow yellow for late afternoon and even to 'warm up' Kodachromes."

Small vs. Large Prints

There has been much ado among pictorialists recently on the subject of the proper size print to submit to exhibitions. The discussion has been precipitated by the growing number of 14 by 17's being submitted and the fact that the large prints generally win out over the smaller ones. One pictorialist even went so far as to refer to a 14 by 17 as a "normal" size enlargement. This was a little too much for the chaps who feel that they can just about afford 11 by 14's and would gladly come down to 8 by 10's if only the judges would not be prejudiced against their offerings on the count of small size.

So the discussion goes back and forth and self-righteous judges, claiming complete impartiality, say print size means nothing, only the picture counts; while exhibitors charge that judges lean to the big prints and are most impressed with them. J. Ghislain Lootens, a well-known judge and teacher, declared that the reason large prints win over the smaller ones is because the distance at which judges usually sit is about right for viewing the 14 by 17's but is prejudicial to the smaller ones. As a cure-all he suggested that prints of different sizes be viewed from different distances appropriate to the size of the print. The 1942 New York Salon of Photography adopted the idea and announced the fact in its entry blank. We shall see how it works out.

Using Etching Knife

Many of the failures of beginners in using the etching knife, whether on negative or print, are due to the desire of the operator to get it over with as quickly as possible. As a result, the amateur holds the knife in such a way that the point digs the offending bit of emulsion out instead of merely *shaving* it off gently and gradually. This operation is easily accomplished, if you will be patient, by repeated applications of the knife at a narrow angle to the negative or paper base. With careful shaving, the black spot in the print can be eliminated without anyone being the wiser, and if too much is removed, leaving too light an area, it is a simple matter to spot it with pencil or spotting color. Shaving undesirable densities on a negative is a more difficult matter, but can be accomplished by persistence and some experience. It is wise, incidentally, to use different knives for negatives and prints, as the delicately sharp edge required by the former may be injured in working on the print.

Wall Paper Backgrounds

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Industrial Chemistry As An Occupation is a six-page leaflet which covers the nature of the work, abilities and training required, income, and miscellaneous advantages and disadvantages. *Occupational Index, Inc., New York University, University Heights, New York, New York Single copies 25 cents, $5 00 a hundred.*

Glue, Plastics and You, by I. F Laucks, is a 16-page bulletin prepared in an attempt to lessen the confusion which now exists regarding the difference between the gluing art and the plastics art. *Laucks News Bureau, I F Laucks, Inc Maritime Building, Seattle, Washington—Gratis*

Lathe Catalog No. 16 is an eight-page pamphlet which describes a line of 16-inch Toolroom Lathes and 16-inch Quick Change Gear Lathes. Attachments, accessories, and tools for these lathes are also listed. *South Bend Lathe Works, Dept S7, South Bend, Indiana —Gratis*

The New Open House is a 32-page pamphlet which presents scores of timely ideas adaptable to civilian and farm home modernization and repairs All of the suggestions given are within the limits set on remodeling and repair by the War Production Board. In addition, many practical ideas for making war housing more attractive and more livable are given. Considerable attention is paid to providing adequate storage space through the use of practical closets *Ponderosa Pine Woodwork, 111 West Washington Street, Chicago, Illinois—10 cents.*

Sturdimatic Heavy Duty Live Centers is a four-page folder giving complete information and specifications regarding standard Morse taper live centers. Illustrated with photographs and drawings *Sturdimatic Tool Company, 5224 Third Avenue, Detroit, Michigan.—Gratis.*

Spectrum Chart is a seven-color chart approximately 30 by 40 inches in size printed on heavy white cloth and bound at top and bottom with wooden rods The entire electromagnetic spectrum is presented, every part of practical significance being analyzed in detail. Emphasis is on uses of each kind of radiation. Terms are defined in a special glossary. Of specific interest to teachers of physics, chemistry, and electrical engineering and to practicing engineers and scientists. *Publications Section, 6-N-17, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.—$2.00.*

Metal Duplicating Without Dies is a 32-page illustrated catalog describing in detail several mechanical devices designed specifically for duplicate forming of parts and pieces to die accuracy without the time delay and expense of die layouts and die sets *O'Neil-Irwin Manufacturing Company. Minneapolis, Minnesota —Gratis.*

Center Scope is a 20-page bulletin which gives instructions for using an optical tool to locate work to the center of a machine-tool spindle, to correct for run-out, and to locate layouts Data are given on available models, edge block and table plug accessories, and typical set-ups. *Center Scope Instrument Company, 631 S. La Brea, Los Angeles, California—Gratis*

Accident Facts—1942 Edition is a 116-page statistical yearbook which gives most of the answers to safety problems According to the National Safety Council, accidents –97 percent of them preventable—cost the nation $4,000,000,000 in 1941 This yearbook analyzes and presents statistics for the previous year and compares them with earlier years *National Safety Council, Inc, 20 North Wacker Drive, Chicago, Illinois - Gratis*

Tin and Its Uses (No. 13) is a 16-page pamphlet devoted to emergency economies in tin This issue of the publication describes practical methods of saving tin in various fields of use Articles describe methods of using solder less rich in tin than usual, using newly developed types of joints on lead pipes, the advantages of thinly coated tin plate, methods of using bearings containing less tin, and so on *Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio —Gratis*

The Rate of Oxidation of Copper, by Addison H. White and Lester H Germer, is a study of the rate of reaction between copper and pure dry oxygen at room temperature and 20mm. pressure The experimental technique is described in detail. *Bell Telephone Laboratories. Inc., 463 West Street, New York, New York—Limited Free Distribution.*

Turner Topics is a four-page folder devoted specifically to users of blow-torches, in an endeavor to enable them to get the maximum efficiency and service from these vital war tools. *The Turner Brass Works, Sycamore, Illinois.—Gratis.*

Steel in a Year of War, by Walter S. Tower, is a summary of what has been accomplished in this industry during recent months, present problems, and a speculative look into the future. *American Iron and Steel Institute, 350 Fifth Avenue, New York, New York.—Gratis*

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METAL is not in the same class with glass for optical surfaces. Your scribe recalls Professor Ritchey saying: "You can't put a real optical surface on metal."

Another man who had worked with both materials comments as follows:

"Glass—like all insulators of electricity—is no good mechanically; but it is homogeneous and it is seldom that a noticeable variation in hardness can be detected in any particular sample. Hence, when one piece is rubbed against another, with an abrasive between, it is to be expected that all parts of the same piece will be similarly affected by the same rubbing speed and pressure. Not so with the metals. The metal is composed of crystals and hence is of varying hardness. If the steel is tempered, the lack of uniformity of hardness is even more noticeable.

"The chances are that the metal mirror maker has two strikes on him before he even starts to work. The chap who uses glass can depend on what he is getting, and be reasonably sure that his next piece will be pretty much the same as the piece he is now using. However, metal is much easier to handle than glass.

"Steel," continues the same man, who wishes to remain anonymous, "cannot be ground disk on disk, because of the tendency to gall. Little pieces pick up and roll into large balls, making deep, torn furrows in the work. Hardened steel is much better in this respect. Hence, I grind and fine-grind the mild steels on a lead lap. The fringes soon become visible and I can almost finish the job on lead. Then a little polishing on pitch, with rouge, gives a gorgeous finish."

A man who has worked with metals for flats is Sydney J. Needs, The Fairfax, 43rd and Locust Streets, Philadelphia, Pa. He is not an amateur telescope maker but an engineer who was aided by "A.T.M." in learning to make metal flats for use in an extended non-optical but high precision mechanical research on boundary films of lubricant in machine bearings, an account of which he published in *The Transactions of the American Society of Mechanical Engineers*, May 1940, pages 331-345.

As he did not there include data on his method of working metal flats, he was invited to describe his technique for these columns. Much of his description will seem strange to the worker in glass but, since amateur opticians often are called on to do precision work on metal surfaces, the technique he developed after much laborious experimentation should go into the permanent record and not be lost. Your scribe has a neat little flat of hardened tool steel presented by Needs. It tests flatter than 1/20 wavelength—a millionth of an inch. Needs writes as follows, in describing his working technique:

"A metal surface produced by the lathe or grinder may be fine ground on a lead lap in preparation for the final polish. The lead lap has the advantages of being easily prepared; it wears away very slowly; and the degree of surface perfection produced may be varied within wide limits. In fact, the lead lap is capable of producing finishes quite satisfactory for most purposes without the necessity of further polishing.

"FOR work up to about 6″ diameter, an 8″ lap is ample. A lap of this diameter should be about 2″ thick, but this thickness ratio is arbitrary and unnecessarily high for laps of larger diameter. The casting is prepared by melting lead of the purest and cleanest grade obtainable and pouring into an oversized wooden mold. To produce a good surface on the work it is necessary that the lap be free of foreign particles. For this reason, scrap lead should not be used. When machining the lead casting, the horizontal table of a small boring mill will be found preferable to the chuck or face plate of a lathe. The outside diameter and the upper face of the casting are finished in one setting. Half inch lifting holes about 1″ deep may be drilled radially from opposite sides midway between the two faces. These holes are useful for holding the lap on the machine table, while the second face is machined parallel with the first, and are necessary for handling the lap when in use.

"Both sides of the lap may be used, one for coarse grades of Carborundum or emery, the better side being used with only the finest grade of abrasive.

"After machining, the faces of the lap should be scraped to fit a plane surface plate. Lead will be found very difficult to scrape, and a poor surface will result unless a few simple precautions are observed. The scraper used is the ordinary flat double-edged hand scraper forged from a discarded file and hardened. Time will be well spent stoning the cutting edges of the scraper until they are smooth and sharp. Lead is so soft that the scraper will remain sharp indefinitely. Place a piece of carpet or several opened newspapers on the bench to form a support for the lead lap. Moisten a clean cloth with lard oil and wipe the upper face of the lap. A thin film of lard oil will remain on the lead and, thus lubricated, the scraper will cut smoothly and without tearing the metal. Scrape the surface until all machine tool marks have been removed. Now clean both lap and surface plate thoroughly, moisten both with lard oil, and wipe dry with a clean cloth. A film of lard oil will remain on each and when the lap is gently rubbed on a surface plate, the trace of lard oil present will be sufficient to lubricate the points in contact. Upon removal of the lap these high points will be found brightly polished; and sufficient lard oil will still be present to lubricate the scraper removing them.

"After a test on the surface plate, remove all high spots, moving the scraper in one direction. After the next test, remove the high spots by moving the scraper at right angles to the previous direction, thus preventing the formation of furrows. Before each test clean the lap and reference plane thoroughly and apply a fresh film of lard oil; then remove as much of it as possible with a clean dry cloth. Should scratches be found on the lead after testing, more care in cleaning is probably indicated. When the contact spots are quite close together and well distributed over the surface of the lead, the lap will be found to float quite freely with no perceptible friction when first placed on the reference plane. This is due to a film of air separating the surfaces and an appreciable time is required for the air to escape. When this occurs, the lap is fairly flat, but the scraping may be carried on as long as patience will permit.

"ONE important detail concerning the use of the scraper must be added. Lead is so soft that merely reducing the pressure on the scraper at the end of a forward stroke is not sufficient to raise the scraping edge and stop the cutting. The scraper must be lifted from the work while still moving forward at the end of each stroke. If this is not done, each stroke will end below the surface of the surrounding metal and a burr will be raised where the scraper is stopped. The forward motion of the scraper removing the high spot has exposed metal, free of lard oil. If the scraper is moved back or a second forward stroke made over this unlubricated surface, scratching and tearing of the metal will result. The chip removed by the forward stroke will be found on the edge of the scraper and must be removed before the next stroke is started. After a few trials, the trick of raising the scraper and removing the chip with a finger will become automatic and require no further attention.

"After the scraping, the lead lap is ready to be charged and used. No grooves are necessary since the lap *is used dry*.

"For charging, a flat cast-iron plate is convenient, having approximately the same diameter as the lap but it need not be as thick. After it is machined all over, one side of the cast-iron plate is finished plane and smooth, either by scraping to fit the reference plane or by the time-honored process of grinding three plates against each other in pairs. Lifting holes similar to those in the lead lap are drilled in the side of the cast-iron plate. To charge the lead lap, No. 600 Carborundum is sprinkled on its scraped surface and spread as evenly as possible with absorbent cotton. The cast-iron plate is gently placed on the lap and moved in several directions with short straight strokes. Ten or 15 strokes should suffice to spread the abrasive evenly and drive some of it into the surface of the lead. After removing the plate, all excess carbo is removed with a cloth and the lap is ready to use (with the work on top). At first the lap will cut rapidly but, after 40 or 50 strokes, recharging is necessary. Before recharging, however, much can be gained by rubbing the work over the cast-iron plate, since this also was charged when charging the lead lap. Being harder, the charged cast-iron plate will cut more rapidly than the lead lap, but the scratches in the work will be much deeper. By using the cast-iron plate and the lead lap on small work, the time required for removing the tool marks will be so short that there seems to be no advantage in using any of the coarser grades of abrasive. The lead lap produces a surface that is quite bright, and, almost from the start, the surface contour may be observed by interference fringes under a master glass.

"In addition to charging the lap, the cast-iron plate makes it possible to keep the work flat as the lapping proceeds. It has been found that, if the lead lap is flat, the work will be slightly convex, particularly if of small diameter. This is probably due to elastic deflections of the lap caused by the pressure applied to the work moving over it To get the work flat, it is necessary that the lap be slightly convex. This is accomplished during charging by rubbing the cast-iron plate on the lead lap with the proper stroke. The plate will tend to become concave and the lap convex in the same manner as spherical mirrors ground by the telescope makers. Should the work become concave, the lap is too convex, and this is corrected during charging by reversing the process and rubbing the lap on the cast-iron plate Thus surface control may be maintained during the process of the work.

"As soon as all tool marks have been removed from the work it is no longer necessary to use the cast-iron plate as a lap, and the finish is made on the lead.

"It is important that the lap be dusted free of all loose abrasive after each charging. The lap will cut faster when loose abrasive is present, but the edge of the work will be badly turned. When the abrasive is sprinkled on the lap, it will fall in small mounds. If these mounds are not broken up the cast-iron plate will be placed on several little hills and the local pressures over such small areas will be sufficient to distort the lead permanantly, causing humps to rise around the depressions. Hence, the necessity of spreading the abrasive as evenly as possible before using the cast-iron plate.

"As stated above, the lead lap cuts comparatively rapidly when freshly charged and it follows that the scratches in the work will then be deepest. When

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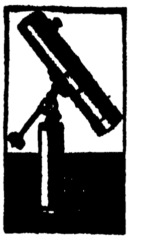

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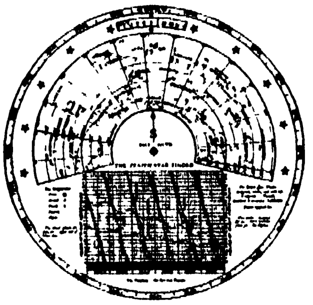

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all tool marks and visible flaws have been removed from the work and the test glass shows the surface to be of the required flatness, the polish may be considerably improved by continued working on the lead lap with no further recharging.

"From time to time, the lap should be washed with soap and water, washed again with clean water to remove as much of the soap as possible, and thoroughly dried with a clean cloth. Continued effort will reduce the depth of the scratches, with a corresponding improvement in polish. Unless removed mechanically or chemically, traces of soap will remain on the lap and these seem to assist by slightly lubricating the surfaces.

"The limit seems to be reached when the surface of the work begins to lose its brightness and take on a cloudy film. This is probably due to all the abrasive being forced into the surface of the lap, thus permitting the work to come into actual contact with lead. By stopping just before this point, the best results with the lead lap will have been achieved. Viewed through the low-power objective of the microscope at this time, the surface of the work is seen to be a mass of tiny scratches. The scratches, however, are very fine indeed and may be entirely removed in a few minutes by rouge on a pitch lap If the pitch lap is flat at the beginning of the final operation, the polishing action on the work will be uniform and the surface contour unchanged by the pitch polisher."

With regard to metals for *optical* surfaces, Needs largely concurs with the anonymous writer first quoted, stating in the *Transactions A.S.M.E.* article cited above that: "There appears to be no metal which, when polished and examined even under low powers of the microscope, will present a surface of uniform surface even remotely approaching that of well-polished glass" If this is so decidedly the case, why then publish anything at all on the working technique for metals? Because of legitimate special uses for metal, and perhaps a little because of human nature. Amateurs will, and do, make metal mirrors.

Needs has told how he avoids turned edge without recourse to the exquisite skill developed by long-experienced makers of flats—simply the "surround" principle ("A.T.M.," page 53). "Turn up a ring (Figure 1) of the same material as used for the flat. Let the outside diameter be about 1" larger than the flat. Turn the outside of the flat a neat sliding fit in the ring. The fit must be good. If ever so little tight the flat and ring will both be sprung. If too loose, fine Carborundum will get between flat and ring and cause trouble when polishing. Heat gently and cement the flat in the ring with beeswax. Finish up, and the turned down edge will be on the ring. To separate, heat, push through hole *A*, and the ring will drop off, leaving the edge undisturbed."

SIXTEEN-INCH CLUB: In July, 1941, we told how Clyde W. Tombaugh, Lowell Observatory, Flagstaff, Arizona, sponsored a "club" of amateurs who, if as many as 20 members could be rounded up, would get a greatly reduced price on 16" Pyrex disks; and in November, 1941, we told of the success of that attempt. We now bring the story up to date.

Some months ago Tombaugh gave us the names of 19 of the Sixteen-Inch Club "members," thus: Dr. C. O. Lampland, Flagstaff, Ariz.; Dr. James G. Baker, Harvard College Observatory, Cambridge, Mass.; Dr. H. Sidney Newcomer, New York; Messrs. John Kshir, 1702 Green St., Phila., Pa.; Harold Simmonds, 517 20th St., Sacramento, Calif.; Arthur Brear, 50 Willow St., Lawrence, Mass.; Lyman H. Allen, 100 Franklin St., Boston, Mass.; Irvin H. Schroader, Angwin, Calif.; Byron S. Warner, 610 S. Reese Pl., Burbank, Calif.; Prof. Newton, Angwin, Calif.; W. L. Whitson, Washington Missionary College, Wash., D. C.; Harry A. Shaw, 2401 Mar Vista Ave., Altadena, Calif.; James J. Connors, 2318 S. 61st St., Cicero, Ill.; A. M. Mackintosh, 70 Arnold Rd., Jamaica, B.W.I.; Franklyn Creese, 269 Davis St., San Leandro, Calif.; Arthur Hugenberger, 2322 Kenworth Rd., Columbus, Ohio; Otto R. Griener, 55 Plane St., Newark, N. J.; Clyde Tombaugh, Flagstaff, Ariz. These ordered a total of 21 disks.

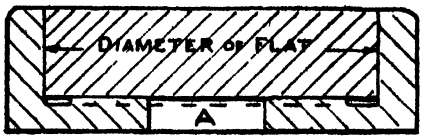

Figure 1: **Surround for tde**

In August, Tombaugh wrote that the total had risen to 33 members and 37 disks, and of the former he knew of the following: Messrs. C. C. Taylor; B. L. Souther, 24 Harrison Ave., New Canaan, Conn.; H. A. Lower, 1032 Pennsylvania St., San Diego, Calif.; J. R. Smith; Russell S. Booker; C. H. Gamble; Marvin J. Vaun; J. W. Fecker; but did not know the addresses of some. "It would be nice if you could publish the list of buyers," he writes, "to keep interest alive This club certainly exceeded my expectations. But I don't think I can do anything more with the Sixteen-Inch Club until the war is over, as I am organizing civilian defense and really am busy. After the war I hope to get the members organized into doing some serious observing."

Admittedly, the lists as given are far from complete or definite. Data are now difficult to round up, because of the war, and personnel is in a relative state of flux. The club has partly passed out of its original organizing control (it really never was a definite organization but a convenience to guarantee Corning the cost of a master mold). As word of the availability of this ideal size for a bigger-than-average telescope has got around, people have gone direct to Corning Glass Works, at Corning, N. Y. for the disks.

Those who build 16" telescopes are invited to keep in touch with this magazine and send in photographs and descriptions.

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50 Years Ago in . . .

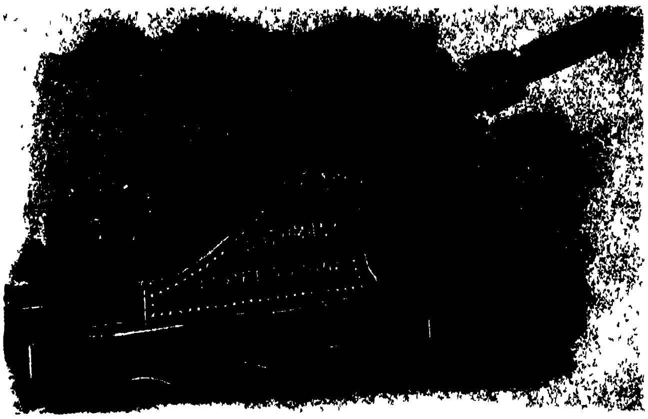
SCIENTIFIC AMERICAN

(Condensed From Issues of November, 1892)

GAS ENGINE—"It has generally been supposed that gas engines were necessarily limited to 30 horse power and under, and that where larger engines are required they must necessarily be made by compounding smaller ones . . . However, a large gas engine made by H. W. Caldwell & Son Company, is rated at 100 horse power. It is operated by carbureted air, consisting of a mixture of common air and gasoline vapor. This provides a fuel which is not only invariable in quality, but is quite inexpensive."

RAILROAD—"The highest railroad in the United States is the Colorado Midland, at the Continental Divide—11,530 feet above sea level."

TORPEDO—"A torpedo designed to be guided in its flight on leaving the gun after the manner of an arrow from the bow, and to continue its course on or near the surface, should it strike the water, is shown in the accompanying picture. The piece of ordnance for starting the torpedo is preferably a breech-loading gun, the torpedo being loaded in from the muzzle The shape and inclination of the wings are such as is designed to uphold and direct the projectile in a straight course through the air, retaining it also near the surface after it strikes the water, until its propelling power is completely exhausted. In addition to the propelling force supplied by the gun at the time of discharge, in the usual manner, this torpedo is provided with further means of propulsion, concealed within the rear portion of its body, the combination being designed to give the projectile a great range and high speed through either the air or water. A 12-inch torpedo of this construction is adapted to carry 350 pounds of a high explosive."



GUN TRIALS—"Some rather surprising results were lately obtained with a new multicharge gun, of Haskell's pattern, half-inch bore. . . . A solid hammered wrought iron target, 7½ inches thick, was penetrated entirely through, backed by a boiler plate ⅜ of an inch thick, which was also penetrated through, making a penetration of 7⅞ inches. This shot was made of Carpenter steel, and the charges of powder were 10 ounces. This penetration is nearly sixteen times the diameter of the projectile, or more than four times greater than has ever been obtained by any other gun."

WIRE GLASS—"The subject of protecting glazed skylights is one which of late years has acquired additional importance. . . . In such structures as the Grand Central Depot in this city, light is given to the interior by large skylights. These are placed in the roof of the building and are of very large area. At a height of nearly a hundred feet above the floor they are a constant menace to life. . . . Wire glass, a substance designed to overcome these difficulties, consists of rolled glass, with iron wire netting embedded in its own substance. Thus the wire is hermetically inclosed, and is secure from corrosion for any length of time."

VOWEL STUDY—"At the recent International Congress of Physiology at Liege, Professor Hermann demonstrated his method of photographing the sound of vowels. The vowels were sung out before one of Edison's phonographs. Immediately afterward they were reproduced very slowly, and the vibrations recorded by a microphone The latter was furnished with a mirror, which reflected the light of an electric lamp upon a registering cylinder, covered with sensitized paper and protected by another cylinder with a small opening which gave passage to the rays of light from the reflector By this means was obtained very distinct photographic traces, and the constancy was remarkable for the different letters."

ARTIFICIAL RUBBER—"Isoprene, which can be prepared from turpentine, under certain circumstances changes into what appears to be genuine India rubber The same change could be brought about by heat The material so produced resembles pure Para rubber in every way, and, whether it is genuine rubber or not, it may be equally good for all practical purposes It is said to be capable of vulcanization"

MAGNETIC EFFECT?—"At the Edison Laboratory, Dr. Fred Peterson and A E Kennelly have sought to prove that no therapeutic effects are resultant from the application of magnetism to the human system. For the purpose of experiment the armature was taken from a dynamo, and in the cylinder formed by the inner ends of the set of powerful converging field magnets a dog was confined and kept for a period of five hours. . At the end of the time the dog was set at liberty, and beyond his apparent joy at thus being set loose the operation did not seem to affect him in the least. A boy was also confined for a short time in the same position and was also uninfluenced. Several other experiments of like nature were made. Dr. Peterson and Mr. Kennelly conclude from their experiments that the human organism is in nowise affected by the most powerful magnets known to modern science."

PHOTO CANE—"In a new photographic cane, the head forms a camera while the tubular body of the cane forms a reservoir for the sensitized celluloid strip. . . . In the cane head near the film is secured a plate, provided with a rectangular aperture through which the exposure is made. . . . The lens is placed in the cane head in proper relation to the exposed portion of the film."

YERKES—"By the munificence of Charles T. Yerkes, President of the North and West Chicago Street Railroads, the University of Chicago is to have a gigantic telescope. His instructions are to secure the largest and best telescope in the world, regardless of expense, and send the bill to him."

98TH YEAR SCIENTIFIC AMERICAN NOVEMBER 1942

'DOWN-UNDER' SHIPS OF THE NAVY

A Submarine Force of Unprecedented Striking Power

WALTON L. ROBINSON

SUBMARINES are among the most effective types of naval craft in existence. Striking without warning from their haunts beneath the surface, they have torpedoed and sunk millions of tons of merchant shipping and ended the career of many a proud battleship and cruiser. In the present conflict Germany's famed U-boats, operating in numbers and with a ruthlessness unknown even in World War I, have sent over 1500 United Nations and neutral merchant vessels to the bottom. They have also destroyed two British dreadnoughts, three aircraft carriers, several light cruisers, and numerous lesser units. Japanese, Italian, and Russian undersea craft have likewise operated successfully, while Britain's relatively few but highly efficient submarines have compiled a truly marvelous record in their attacks on Axis convoys and naval units off the Norwegian coast and in the Mediterranean. More recently American submarines, striking viciously at Japan's sea power in the Pacific, have sunk several of the Mikado's cruisers and destroyers and a large number of his troopships and supply vessels. One submarine, the *Seawolf*, sank one and probably two Japanese light cruisers, a destroyer, and a large transport, and damaged a third cruiser, a transport, and an unidentified ship—all in a single cruise!

On the outbreak of war with Japan the United States Navy possessed one of the largest and finest submarine forces in the world. Germany and Russia had many more undersea craft, but their boats were considerably smaller than ours and incapable of operating as far from base over an extended period. Japan also possessed a large number of submarines, many of which could cross the Pacific and operate off our west coast. Most Japanese submarines were somewhat larger than ours, but they have had only limited success against our warships and transports.

● *Fifth of a series of analytical articles on ships of the United States Navy. Previous articles covered battleships, aircraft carriers, cruisers, destroyers, and appeared in our issues for May, August, September, and October of this year.—The Editor.* ●

In December, 1941, a total of 111 American submarines were in service with 73 others under construction. Many additional boats have since been laid down, while still more will be commenced under the 200,000-ton increase approved by Congress last April. The submarines in service ranged in size from 480 to 2730 tons surface displacement and were of 12 distinct types, some composed of several classes varying in minor details. Forty-seven of our undersea craft—those completed since 1928—were of modern design. The remaining 64, commissioned between 1918 and 1926, still retained considerable value, particularly for training purposes. All of our submarines were painted black and carried their serial numbers in white on conning towers and bows.

SMALLEST and oldest of our submarines were the seven units of the "O" class, authorized in 1915 and placed in service three years later. Ten boats *(O 1-10)* originally comprised this class, but three were lost or scrapped. The *O 5*, wrecked in 1923, was salvaged, but not considered worth repair; *O 1* was converted into an experimental vessel in 1937 and scrapped the following year; *O 9* was lost June 20, 1941, by submerging beyond her safe diving limit, the pressure of the water crushing her old hull like an egg-shell.

The "O" boats are 172 1/3 feet long over-all and displace 480 tons in surface trim and 624 tons when submerged. On deck and forward of the conning tower they mount a 3-inch, 23-caliber anti-aircraft gun, while below the water-line in fixed positions in the bow are four torpedo tubes firing "tin fish" of 18-inch diameter. Eight torpedoes can be carried, four in the tubes and four in reserve. These submarines have two sets of 440-horsepower Diesels for surface cruising and two 370-horsepower electric motors for use when submerged. Current for the latter is supplied by storage batteries. On the surface a speed of 14.5 knots can be attained; while submerged, 11 knots is maximum. Cruising range is about 3000 miles. Each of these submarines is manned by 32 officers and enlisted men.

THE "O" boats were followed into service in 1918-19 by 20 units of the "R" class *(R 1-20)*. One of these, *R 8*, was scrapped in 1936 and another, *R 3*, was transferred to Britain late in 1941 and is now His Majesty's Submarine *P 511*. The "R" boats, measuring 186 feet in length and displacing 530 tons on the surface, are simply enlargements of the "O" design from which they differ principally in having a 50-caliber 3-inch gun and more powerful electric motors (two sets totaling 934 horsepower). Most of the "R" boats spent many years in reserve until recommissioned during 1940-41, but about six of them were always retained in service for training duties at the Submarine School, New London, Connecticut.

In 1919 the submarines *S 3* and *S 4*, first of a very numerous group, were placed in service. During 1920-25 they were followed by 49 additional "S" boats. Twelve units *(S 2-4, 6-10, 19,* and *49-51)* were scrapped during 1930-37; one, *S 5*, was lost in 1920; and another, *S 25*, was transferred to Britain last year and now serves as the Polish *Jastzrad*. Thirty-seven boats were, therefore, still in service when hostilities with Japan commenced. One of them, *S 26*, was lost by collision off Panama in January last.

The "S" boats are of five types. The *S 1, S 18, S 20-24,* and *S 27-41,* all completed in 1920-24, are 219¼ feet long, displace 800 tons on the surface, mount one 4-inch, 50-caliber gun, and have four bow tubes firing 21-inch torpedoes. Eight reserve torpedoes, additional to the four in the tubes, can be carried. Two sets of 600-horsepower Diesels give a surface speed of 14.5 knots, and two 750-horsepower electric motors a submerged speed of 11 knots. About 45 officers and men comprise the complement of each of these submarines.

The *S 11-13* displace only 790 tons, but are a half-knot faster on the surface, have an extra torpedo tube (located in the stern), and carry 14 torpedoes. They are engined with two sets of 1000-horsepower Diesels and two 600-horsepower electric motors. The *S 14-17,* also of 790 tons, have only four tubes, twelve torpedoes, and 14 knots speed.

The *S 48,* commissioned in 1922, is the largest of the "S" boats. She is 267 feet long, displaces 1000 tons, and is armed with a 4-inch gun and five torpedo tubes (four bow, one stern). Very handy for her size, she can "crash dive" in 60 seconds.

The last of the "S" series were commissioned in 1924-25, when the *S 42-47* entered service. They are 850-ton craft with armament and engines similar to those in the *S 1* group.

After the completion of the "S" boats, submarine construction in the United States dropped sharply, and only nine new undersea craft joined the fleet during the period 1925-34. With three exceptions, however, they were of remarkable size and cruising range. First of these boats were the *V 1, V 2,* and *V 3,* now the *Barracuda (B 1), Bass (B 2),* and *Bonita (B 3).* Built in 1921-26, they displace 2000 tons (2506 tons when submerged) and have an over-all length of 341½ feet. Their armament consists of a 3-inch, 50-caliber gun, six 21-inch torpedo tubes (four bow, two stern), and 10 reserve torpedoes. Diesels developing 6700-horsepower provide the surface motive power, but designed speed of 18.75 knots has never been realized in service. There are also two auxiliary Diesels which drive generators supplying current to the 2400-horsepower electric motors, which under this arrangement can be used for cruising on the surface without depleting the storage batteries. Radius of action is about 12,000 miles and submerged speed is 11 knots. A complement of 80 officers and men is required to operate each of these big submarines.

In 1928 the Navy commissioned its first mine-laying submarine, the 2710-ton *V 4,* which is now the *Argonaut (A 1).* When placed in service she was the largest undersea craft in the world, this distinction having previously been held by Britain's *X 1,* experimental giant of 2450 tons. The *Argonaut* was laid down in 1926 and cost about $6,000,000 to build. She is 381 feet long, displaces 4080 tons when submerged, and has a complement of 88 officers and men. Two 6-inch, 53-caliber guns are mounted fore and aft of the conning tower and four 21-inch torpedo tubes are in the bows. Aft is the mine-laying gear and stowage for 60 mines. The *Argonaut* was originally engined with 3175-horsepower Diesels designed to give a surface speed of 14.6 knots, but these engines proved unsatisfactory in service and new ones, incorporating Diesel-hydraulic drive, were recently installed. Submerged speed is 8 knots, obtained by 2400-horsepower electrically driven motors.

U. S. Navy Official Photo

At the command, "Blow ballast tanks!" this submarine training ship surfaced

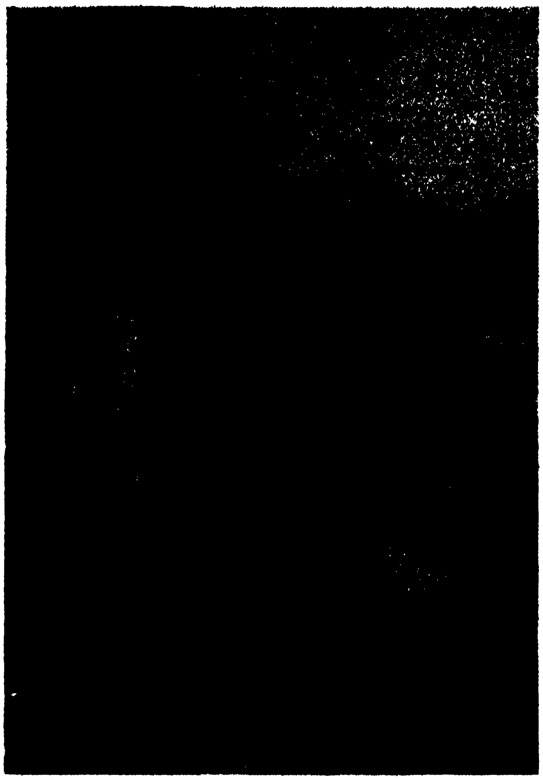
U. S. Navy Official Photo

One of the *Albacore* class, authorized in the 1940 program

The *Narwhal (N 1)* and *Nautilus (N 2),* commissioned in 1930, are of about the same size as the *Argonaut* and greatly resemble her in appearance They are 20 tons heavier on the surface, but are not quite as long (371 feet) and displace only 3060 tons when submerged—120 tons less than the *Argonaut.* These three submarines are our largest and, since the loss early this year of the huge Free French *Surcouf* (2880 tons), the largest in the world. Laid down in 1926 as the *V5* and *V6,* the *Narwhal* and *Nautilus* have two 6-inch guns and four bow and two stern tubes. Eight reserve torpedoes can be carried; they are stowed externally under the half-deck amidships These two submarines were completed with 5450-horsepower Diesels for a surface speed of 17 knots. but this was never realized in service and new engines were ordered in 1940. Electric motors of 2540 horsepower give a submerged speed of 8 5 knots

In 1932 the *V 7,* now the *Dolphin (D 1),* was completed. Displacing only 1540 tons on the surface and 2215 tons submerged, she marked a distinct breakaway from the huge dimensions of the earlier "V's". Her over-all length is 319 feet and her armament consists of one 4-inch gun and six torpedo tubes, four bow and two stern Three reserve torpedoes are stowed externally. Engined with 4200-horsepower Diesels and 1750-horsepower electric motors, the *Dolphin* can make 17 knots on the surface and 8 knots submerged. She requires a complement of 64 officers and men.

Last of the "V" boats were the *V 8*



U. S. Navy Official Photo

The *Gato* goes down the ways to the sea

and *V 9*, now the *Cachalot (C 1)* and *Cuttlefish (C 2)*. Begun in 1931 and completed in 1933 and 1934 respectively, they were the first all-welded submarines built in the United States The *Cachalot* (1110 tons surface displacement) and the *Cuttlefish* (1120 tons) differ from the *Dolphin* as much as she differs from the *Narwhal*. Only 271¾ feet long, they mount one 3-inch anti-aircraft gun *abaft* the conning tower and have four bow and two stern tubes. There is no external torpedo stowage. Surface speed is 17 knots (3100-horsepower Diesels) and submerged speed 9 knots (1600-horsepower electrics).

With the advent of the present administration in 1933, American submarine construction took a sudden spurt and during the period 1933-39 work was begun on 40 undersea craft, all of which were completed before Japan struck her Pearl Harbor blow. These submarines were of four distinct classes, three of which contained two or more groups varying slightly in minor details

Ten "P" class submarines, authorized by the 1933 and 1934 Naval Building Programs, entered service in 1935-37 They were armed with a 3-inch gun abaft the conning tower and four bow and two stern torpedo tubes. Diesel engines of about 6000 horsepower gave them a surface speed of at least 20 knots. Radius of action approached 12,000 miles and cost averaged $2,400,000 exclusive of armament. This fleet of 10 submersibles included the 1310-ton *Pike* and *Porpoise*, the 1335-ton *Plunger* and *Pollack*, the 1315-ton *Shark* and *Tarpon*, and the 1330-ton *Perch*, *Pickerel*, *Permit*, and *Pompano*. Winton Diesels were in all boats except the *Plunger* and *Pollack*, which had Fairbanks-Morse, and the *Pompano* (Hooven, Owens and Rentschler) Six boats had Elliott electric motors; three, General Electric; and one, *Pompano*, Allis-Chalmers. Two of these submarines, *Shark* and *Perch*, were lost in the Far East early this year.

Sixteen submarines were authorized in 1935-36 They were simply enlargements of the "P" design with two additional torpedo tubes in the stern. The 1935 boats were the 1450-ton *Salmon*, *Seal*, and *Skipjack*, and the 1445-ton *Snapper*, *Stingray*, and *Sturgeon*. The 1936-37 boats were the *Sargo*, *Saury*, *Spearfish*, *Seadragon*, *Sealion*, *Sculpin*, *Squalus*, *Searaven*, *Seawolf*, and *Swordfish*. Displacing 1475 tons, they were slightly improved editions of the *Salmon* group, from which they differed principally in having somewhat larger conning towers and heavier periscope housings. Each cost about $5,000,000 fully equipped.

One of these "S" boats, the *Squalus*, foundered on diving trials May 23, 1939, but was subsequently raised and repaired; she is now in service as the *Sailfish*. Another, the *Sealion*, was undergoing repairs at the Cavite Navy Yard, Manilla, when hostilities broke out, she was badly damaged by air bombs and eventually had to be blown up to prevent her falling into enemy possession She was our first submarine loss of the war

The 1938 Program provided for six more submarines, the *Tambor*, *Tautog*, *Thresher*, *Triton*, *Trout*, and *Tuna*, all of which were completed in 1940-41. They displace 1525 tons, have a 3-inch gun, *six* bow and four stern tubes, and a designed speed of 21 knots, obtained by 6400-horsepower Diesels. They can be distinguished from the several preceding classes by their hull form, particularly at bow and stern.

Eight submarines were authorized by the 1939 Program and entered service two years later. These were the *Gar*, *Grampus*, *Grayback*, *Grayling*, *Grenadier*, and *Gudgeon*, all 1525 tonners, near duplicates of the *Tambor* design. The *Mackerel* and *Marlin*, however, are relatively small craft of an entirely new design. They displace only 800 tons on the surface, are 253 feet long, mount one 3-inch gun, and have four bow and two stern torpedo tubes. Their Diesel engines develop 1600 horsepower for an estimated 14.5 knots. Submerged speed is reported to be 11 knots.

All of the 73 submarines under construction prior to December 7 last were 1525-ton craft. The *Gato*, *Greenling*, *Grouper*, *Growler*, *Grunion*, and *Guardfish*, authorized by the regular 1940 Program, are slight modifications of the *Gar* design with two engine rooms instead of one to reduce the size of compartments. The *Gato* was commissioned just after Pearl Harbor; the others followed her into service within a few months. These "G" boats are the last of our "Alphabetical" submarines.

Sixty-five undersea craft were ordered under the War Emergency Program of 1940. Two more were ordered in April, 1941, 23 in the following December; and others since. The 1940 boats are of the *Albacore* class which is practically a copy of the *Gato* design Ten of them are being built in the Middle West; they will proceed to sea via the Mississippi and fit out in Gulf ports. Some of the newer submarines may be modifications of the 800-ton *Mackerel* type.

The completion of the above submarines and of the many additional ones to be built under the 1942 Program will give the United States Navy an undersea force of unprecedented striking power and cruising range. We shall then be able to maintain numerous submarines on constant patrol off Japan's principal naval bases and along her vital lines of communication in the Southwestern Pacific. Such an undersea offensive will do much to cripple Japan's strength and hasten her downfall.

❡*While this description of America's submarine fleet completes the originally announced series of five analytical articles on ships of the United States Navy, we now have under preparation two supplementary articles which, when approved for publication by the proper authorities, will cover, first, the air power of the Navy, and, second, the tactical usage of each branch of our naval fighting forces. We hope to have these available for publication soon.*—The Editor.

What Is Being Done About Cancer?

Recent Experiments Begin to Give a Discernible Picture of Cancer's Cause, and Provide Methods

●Research on cancer is pursued in many institutions the world over. Broad and significant is the research pursued at Memorial Hospital, New York. Outstanding is the accompanying account of that research, written for lay readers by Memorial's director, Dr. C. P. Rhoads, in the hospital's biennium report, "Record of Service," from which it is extracted.

Memorial Hospital is the pioneer American cancer hospital. In it, combined under one roof, are facilities for the treatment of every phase of cancer; also all equipment and facilities for cancer education and prevention, and, especially, cancer research. —*The Editors.* ●

The body tissues are made up of quantities of cells, of which different types form different organs and body structures. When the normal body has reached its full growth, these cells stop increasing in number and, although they may die and continually be replaced by new ones, the replacement is held within the normal limits of body form. This control is exerted supposedly through the action of chemical processes which limit the rate of growth of the normal cells. Under specific conditions, however, some cells become immune to these chemical control processes provided by nature and are no longer subject to the growth restraint which handicaps the normal cells surrounding them. In this way the normal cells are overgrown and are killed by their inability to compete for nourishment. This overgrowth of uncontrollable tissue is called cancer. It seems clear, then, that the cancer cell, which is not susceptible to chemical control, must differ in chemical constitution from the normal cell, which is susceptible to control

If a disease is due to uncontrolled malignant overgrowth, two possibilities for its cure exist: to render normal the abnormal cell, or to destroy that cell. The first possibility does not appear to be a likely one, since from all the evidence it appears that the malignant cell is irreversibly changed and can never be rendered normal again. The second possibility, that of destroying the malignant cell, is one already proved to be feasible by the vast amount of clinical experience with the partial destruction of cancer cells by X-ray and radium These agents are only weakly effective, however, and better ones are required.

Research on the problem of cancer has been in progress for a great many years. A review of its progressive development serves to indicate its complexity and difficulty. The first method of attack was the application of morphological pathology, the science of the form of abnormal or diseased cells. This science made it possible to recognize, under the microscope, characteristics by which cancer cells can be differentiated from normal cells. The differences are of two types; one of shape, and the other of the affinities of the various types of cells and parts of the same cell for colored dyes.

The use of coloring brought into sharp relief the features of the affected cells. It revealed details, previously unknown, that clarified the way in which cancer destroys the body. Under the microscope, in a thin slice of an organ affected with cancer—the breast, for example—can be seen the finger-like processes of the parasitic cancer tissue invading and destroying the normal structure. It is perfectly apparent to any observer that the cancer destroys by its superior strength In short, it wins a battle with the normal tissue—a battle which results in the destruction and dissolution of the defeated normal cells.

The ability of cancer tissue to outfight the structure of which the normal organ is composed has excited enormously the interest of scientists for over a century. From the appearance of the cancer cells, all sorts of deductions were drawn as to how the cancer cell gained its superior fighting ability, or, as expressed more commonly, its "malignant quality." The study of the form and staining qualities of the cancer cells became an invaluable tool by which various types of new growth could be distinguished one from the other. Once distinguished, the expected natural course, extent, and proper sort of treatment could be indicated.

It was then observed that cancer developed in animals, and was indistinguishable in every respect from that occurring in man. Attempts were made to transfer animal cancer to normal animals It was found that this could not be done unless closely related individuals of the same species were used as hosts. If such related subjects were available, some tumor tissue removed from the cancer-bearing animals could be inoculated into the closely related normal animals, it would grow and flourish, and could, in turn, be transplanted to other normal animals. The process could be continued indefinitely as long as related animals were employed in the experiments.

The proof of the transplantability of animal cancer was an important advance, since it indicated that, once a tissue cell has undergone the transformation into a cancer cell, it could be transplanted through an indefinite number of normal hosts and always remain a cancer cell. In other words, in cancer one deals with a mutation, or permanent alteration of the cell, which is reproduced through its offspring forever. This proved that it was hopeless to expect the return of cancer cells to normal. Clearly, then, in order to cure cancer, it was necessary to kill the affected cells, or to remove them from the body of the host.

A little later another advance was made. Peyton Rous showed that, in the case of tumors of fowls, the malignant tissue could be transplanted even though the affected tissue was ground up and passed through a filter which would not let cells through. The cell-free filtrate, when inoculated into normal fowls of the same species and strain, gave rise to cancer of the type from which the filtrate was devised This proved that, in fowls at least, cancer could be caused by some part of the cell, and to this part the term agent or virus has been applied.

At this point two basic principles were apparent: 1) that of the abnormal form and staining qualities of the cancer cells, and 2) that of the transplantability of animal cancer. The next step required the development of an entirely new science, that of chemistry.

In 1756 Percival Pott conceived from pure clinical observation the unique idea that some cancer was due to tar. Later it was found that the application of tar to the ears of rabbits caused cancer. This experiment provided the possibility of isolating from tar and identifying the compound which caused the cancer. Two English chemists were finally successful in this attempt. They isolated from tar a few granules of a pure cancer-producing substance and then many similar compounds could be quickly synthesized. The exact molecular structure required for cancer production was clearly delineated in this way.

At about this time the chemical nature of the compounds which are secreted as sex hormones by the body came under study. It was found that these compounds had a structure similar to the cancer-producing tar constituents. Furthermore, the injection into mice of certain human sex hormones resulted in cancer of the breast and other organs. Conversely, the injection of certain of the cancer-producing compounds caused sex changes in animals. Clearly, it was possible that cancer in man had to do with some improper or abnormal formation of sex hormones. The abnormal chemical manufacture might result in the formation, not only of normal sex hormones, but also of small amounts of "bad hormones," structurally allied substances which cause cancer. This possibility is considered to be so important that it warrants completely the serious investigation now in progress.

THE most recent experiments which bear on the cancer problem concern the effect of diet on the formation of chemically induced cancer in laboratory animals. The fact has been established that certain types of compounds will regularly cause cancer if they are administered while the animal is fed a diet lacking in certain vitamins and other food constituents. If these lacking constituents are added to the diet as supplements, and the administration of the chemical is continued, no cancer occurs. Obviously, in these experiments some food factor protects the animals against cancer.

The experiments described may seem to be unrelated and without application to the problem of cancer in man. As a matter of fact, the results now begin to form a discernible picture—one, to be sure, with many gaps, but still clearer than has ever been available heretofore. The picture is somewhat as follows: Something goes wrong with the manufacture in the body of those chemicals which are similar in structure to the sex hormones. The error in manufacture gives rise to small quantities of compounds which, by their structure, possess the power of changing normal cells into cancer cells.

This process of change is due to the ability of the chemical to interfere seriously with the life processes of normal cells. The cells are poisoned incompletely, and, in an attempt to live under these circumstances of chronic poisoning, they develop vital processes which are not affected adversely by the poisonous compound. In short, the cells become tough—so tough that they can compete successfully with normal cells in the race for nutrition. Then they destroy the normal tissues.

If we are satisfied to accept this hypothesis as the correct one—and its correctness seems to be attested to by the available evidence—another attack on the cancer problem may be at hand. One thing that could be done would be to examine carefully patients with cancer to see whether from their excreta we could isolate the abnormal hormone which caused the cancer. Perhaps in this way the difference in hormone formation between normal and cancer-bearing individuals could be distinguished. Perhaps the offending compound could be isolated and identified. If this were the case, undoubtedly we could develop methods for rendering normal the deranged hormone formation which led to the production of the poisonous cancer-producing substance.

Memorial Hospital, New York City

This sounds like an easy task On the contrary, it is one of the most difficult problems in modern chemistry One example of the truth of this statement is the fact that the chemist who first described the chemical structure of the male hormones was able to isolate from thousands of gallons of urine about as much of the compound as could be placed upon the tip of a pencil.

At Memorial Hospital, with the help of Harvard University, we have had the temerity to attempt to isolate and identify all the compounds of this type in the urine of normal individuals and of individual patients with cancer A number of new, hitherto undescribed substances have been isolated and are being identified. The existence of a difference as concerns these compounds in the urine of normal individuals and of cancer patients appears to have been demonstrated.

The study just indicated is an enormously expensive one, requiring a large staff of highly trained individuals, as well as a tremendous outlay for chemicals and equipment, but the reward is certainly worth the sacrifice. If an analysis of the urine of patients for the presence of these various hormone-like substances could be made, it might provide for medical investigation a technique of almost unimaginable scope. We feel confident that this will be the case, but it is not a matter of a few months or even a year or two.

A second line of investigation concerns the nutrition of cancer cells and of normal cells of similar origin. This may seem to be a fanciful type of study. It is not entirely so, however, since we know from our experience with the sulfanilamide type of drugs that one way of destroying foreign cells like bacteria is to starve them by withholding from them certain compounds which they require for nourishment. This can be done because bacteria—for example, the streptococci—are nourished by essential substances in their diet, exactly as the whole body of a human being is nourished by, and cannot survive without, food containing sufficient vitamins. Moreover, the requirement of these bacteria for food differs, certainly quantitatively, and almost certainly qualitatively, from those of normal tissue cells. In other words, by the administration of compounds, like sulfanilamide, it is possible partly to starve and to strangle (by an interference with the breathing mechanism) the bodies of bacteria causing disease. This can be done by concentrations of the drug which are not seriously poisonous and do not strangle markedly the normal tissue cells of which the body is composed.

IN view of what is known about the antibacterial drugs, it is clear that, in order to apply the same principle to the starvation, strangulation, and eventual destruction of cancer cells without exerting the same effect to the same degree on the normal cells of the body, one must know upon what substance cancer cells depend for their ability to breathe and to be nourished. This is a very difficult problem, but probably one not impossible of solution.

Two roads of attack are open: one, to measure exactly the requirement of the patient with cancer, as compared with the normal individual for essential dietary constituents. This is done by ascertaining the amount of these substances taken in and excreted in a given period of time, thus provid-

In Memorial's child cancer department. Child cancer is not at all uncommon

ing a level of nutritional balance. By the determination of such a balance, one can measure accurately amounts of food substances essential for different individuals.

A second method is the measurement of the amounts of essential or required dietary substances in the cells of normal organs and of cancer cells growing in the same organs. Suppose, for example, it were found that normal liver tissue contained a given number of units of a vitamin, whereas cancer tissue of the same liver contained and required a greater amount. We could then hope that the cancer could be destroyed by the institution of a deficiency of that vitamin.

The studies of nutritional balance have already provided information of interest and very possibly of eventual importance. The fact has been established, for example, that patients with cancer of the stomach have a strikingly disordered reserve of Vitamin A, the fat-soluble vitamin contained in cod-liver oil. It appears that, with the growth of cancer of the stomach, the ability of the body to store and to distribute vitamin A to its tissues is seriously impaired.

Even though enormous quantities of vitamin A are administered to the patients in an attempt to support in every way their general health and their ability to stand operation, it is very difficult to render normal their handling of this vitamin. This observation takes on even more importance in view of the fact, established last year and confirmed at Memorial Hospital laboratories, that the administration to animals of synthetic cancer-producing chemicals renders abnormal their handling of, and reaction to, Vitamin A. Indeed, a vitamin disturbance quite similar to that seen in human beings with cancer can be produced in these experimental animals.

NOT only is a disturbance of vitamin A found in patients with gastro-intestinal and other forms of cancer, but in leukemia, a cancer of the blood-forming cells, striking disturbances of the utilization and activity of another vitamin, thiamin, or vitamin B_1, have been shown in the Memorial Hospital laboratory, to be present. This demonstration required the development of entirely new methods of assaying the amount of the vitamin in very small amounts of tissue cells. The substance is measured in the affected cells, the leukocytes or white blood cells, themselves. Since the actual volume of these white blood cells in blood samples which can be removed safely from patients is comparatively small, extraordinarily delicate methods for vitamin measurement were required. When these were applied, a very interesting fact developed. The white blood cells of cancerous nature, leukemic cells, have a much higher content of vitamin B_1 (thiamin) than do any normal white blood cells examined.

This observation has been extended to show that the leukemia, or blood cancer cell, appears to possess chemical activities which are not different from those in the normal blood cell. Rapid progress is being made in our knowledge of these significant differences. We hope, by taking advantage of them, to be able specifically to injure or kill the cancerous blood cells without injury to its normal analogue.

Not only must we search for differences between the cancer and the normal cells, but we must also find points of similarity, since otherwise the differences would not be significant for our purposes of developing methods of cure. Differently expressed, if the amounts of some vitamins in cancer and normal cells were the same, but the amounts of other vitamins were strikingly different, one would feel more secure in attempting to use the difference as a route of attack. Such experiments are also in progress.

No conclusion can be drawn so far, except that the methods hitherto described for the measurement of vitamins in cancer appear to be somewhat unsatisfactory. If this seems to indicate that little progress has been made, the fact should be recalled that every one of these determinations requires the development of exceedingly difficult technical methods.

A third set of studies is in progress in an attempt possibly to short-circuit the more prolonged investigations and to develop a method of cure without exact knowledge of the mechanism by which the cure would be effected. This means a purely empiric study and such a one has been instituted. A method was devised by which the effect of compounds in poisoning cancer could be measured precisely The experience with the chemical antibacterial agents, the sulfa compounds, in inducing the death of bacterial cells by their starvation, suggests, of course, that similar methods might be effective in killing cancer cells.

AS far as the experiments have gone, some 70 different compounds have been tested in the manner described. A type of chemical has been found which, in the test tube, appears to interfere with the health of one type of cancer cell of man—that found in cancer of the breast—and in the same concentration not to interfere with the well-being of any normal organ tissue so far tested.

The results may have a far-reaching significance. They prove apparently that there is a real difference between cancer cells and normal cells in their sensitivity to certain types of chemicals. The cancer is more sensitive and can be killed by compounds which do not kill the normal tissue. This observation alone is sufficient justification for the intensive continuation of the experiments.

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BORN THAT WAY

A Practical Solution for the Constitutionally Inadequate

"THE main trouble with many of the patients I see every day," says Dr. Walter C. Alvarez, noted stomach and intestinal specialist of the Mayo Clinic and author of the book "Nervous Indigestion," writing in *The Journal of* *the American Medical Association,* "is that they are always weak and tired and full of pains and always getting sick in one way or another. Many have been operated on several times, but they still aren't well and they cannot get about and have fun as other people do.

"Again and again these patients go to some consultant or medical institution with the idea that this time they will get examined so thoroughly that the cause of all their troubles will be found and perhaps removed.

"Commonest among the diagnoses made nowadays in the hope of explaining the sufferings of these people are colitis, spastic colon, ptosis, pelvic disease, adhesions, chronic appendicitis, glandular dysfunction, low blood pressure, mild Addison's disease, low blood calcium, brucellosis, and chronic nervous exhaustion. That in a given case the diagnoses made in the past were wrong and the local abnormalities found were not sufficient to explain the illness can be seen from one fact alone, and this is that the extensive treatments carried out and the operations performed in an effort to correct the supposed diseases did not put an end to the symptoms.

"The question then is, How can matters be improved? It seems to me that, to begin with, we physicians must recognize more often and more promptly the constitutional frailness or sickliness of these patients and the inherent incurability of their disease. We must stop looking hopefully for some one lesion to explain the disability, the psychoneurosis, and the aches and pains everywhere, and we must not let ourselves be led astray by those little variants from normal that we can usually turn up during an examination.

"Treatment must consist mainly of keeping the patients from doing foolish things and wasting money. They must be taught, if possible, to acquiesce to the situation, to stop hunting for a complete cure, to hoard their energies, and to find a job that can be done without too much fatigue."

CHILD OUTLOOK

Mental Attitude Toward the Present War

CHILDREN between the ages of 7 and 13 reflect the cynical, disillusioned attitude prevalent just after World War I, with no positive idea of what we are fighting for this time, according to a study made on the Children's Ward by two Bellevue Hospital, New York, psychiatrists, Dr. Lauretta Bender and Dr. John Frosch.

The war so far has had no disturbing mental effect on these children, although they reacted with fear and anxiety to the threat of being separated from their parents. This conclusion, confirming British blitz experience, is reported by Dr. Bender and Dr. Frosch in the *American Journal of Orthopsychiatry.*

Although the children agreed that "war was bad," war has no very personal meaning to the average young child, according to these psychiatrists. Death and killing do not mean the same to them as to adults. In the few cases of anxiety over the war, this seemed to be due primarily to personal, emotional problems at home. "Glorification of war was conspicuous by its absence and surprisingly few thought of war in terms of bravery, heroism, freedom, and patriotism," these observers found. "If anything, there was a glorification of peace."

GERM KILLERS

Ultra-Violet Lamps Put To More New Uses

TWO new applications of the Westinghouse-developed Sterilamp, a source of ultra-violet radiation for germicidal purposes, have recently been put into practice. The principle of operation of the Sterilamp has been described previously in these columns, as have also various applications as developed.

Electrical sterilization of footwear prevents spread of infection by shoes

First of these newest uses is to prevent foot infections being spread through the use of safety shoes in industry. In one of the Westinghouse plants approximately 1000 workmen buy steel-capped safety shoes every month, and most of them try on several pairs before making a selection. As one of our illustrations shows, those shoes which have been tried on and are to be put back in stock are first electrically sterilized by being placed over a U-shaped Sterilamp for from two to five minutes.

Second ultra-violet germicidal application recently announced is the use of these same lamps, but in larger sizes, to kill bacteria in air-conditioning air ducts. Another of our illustrations shows ultra-violet lamps arranged for this purpose The air being drawn through the ducts passes over the surface of the lamps which are so staggered in placement as to stand guard over all of the passing air. It is claimed that such an installation will destroy 95 percent of the bacteria in the air passing through the duct.

These ultraviolet ray lamps will help to purify the incoming air in ducts

JAP MALARIA

Scarcity of Atabrine May Cause Military Reverses

HIGHLIGHTS on how Chinese universities are carring on in spite of Japanese invasion and oppression were related at a recent meeting of the American Chemical Society by Prof. Clinton N. Laird of Lingnam University, who returned with Mrs. Laird on the *Gripsholm* after a wearing time while interned in Hong Kong.

Questioned about causes for the recent Japanese reverses and retirements, Prof. Laird said he thought one factor might be disease, especially malaria. The Japs depend more on atabrine than they do on quinine for treatment of malaria, and since their former bulk source of atabrine in Germany has been cut off they appear to be hard up for the drug.

Day After Tomorrow

A Continuation of the Report on How Industry is Planning Now for Peace-Time Operations

A. P. PECK

(In Two Parts—Part Two)

NEXT on the list of industrial executives to be questioned in the Scientific American industrial survey was Charles E. Wilson, president of General Electric Company.

"Obviously any plan for the post-war 'day after tomorrow' has to find its seed in yesterday," said Mr. Wilson. "This is particularly true, we feel, in the case of the electrical industry, in respect to both manufacturing and the distribution of power. The war effort has added tremendously, and is still adding to generating capacity. While the efficient use of these great amounts of electricity for the common good is primarily a problem for electric utility companies, it necessarily figures largely in the plans of equipment manufacturers such as General Electric, who build not only power-producing machines, but also the devices and appliances to use the power.

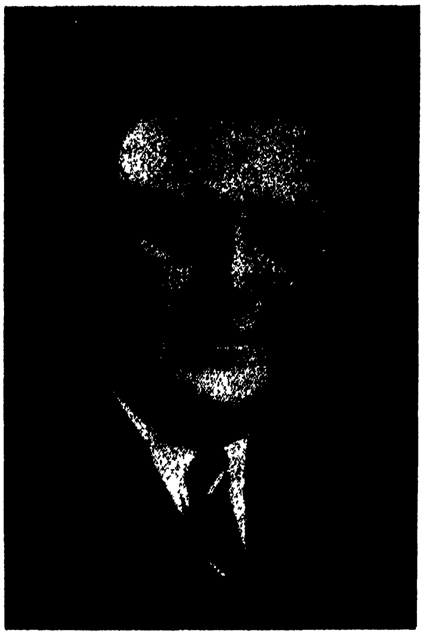
"There are two aspects of the 'war power' problem which are interesting to us," Mr. Wilson continued. "One is that existing central station installations are under a heavy strain—the turbines and generators and related equipment are being subjected to the severest kind of use and many of them may be worn out or have their operating efficiency seriously impaired. They will need to be replaced. The other aspect is that in certain sections of the country greater amounts of power will be available for use than ever before, once the emergency is past. Increased use of domestic home appliances, particularly for cooking and water-heating, will absorb part of this new capacity, but new industrial uses of electric power will also open up. There will be the need for modernization of plants to undertake new manufacturing tasks, and new methods of producing the highly competitive fabricated materials such as steel and aluminum will draw heavily on electric power. As we see it, these things all represent opportunities for post-war business — but opportunities in the sense that they must be planned for, sought out, and realized through aggressive action. They will not just fall into anybody's lap.

● IN last month's issue were presented the views of executives of Westinghouse Electric and Manufacturing Company, Aluminum Company of America, and Lincoln Electric Company as revealed in answer to questions, the essential one of which was: To what extent are research, development, and invention, as prompted by war-time production, being correlated with plans for civilian production in post-war days? The questions were asked as part of a survey to determine for the American people what sort of a post-war world they may expect if industry is permitted to apply to its operations the fruits of present-day research and development.

Exigencies of space prevent repeating here the introductory and explanatory material published last month, and it is therefore suggested that readers who missed the first part of this article refer to page 151, October 1942 Scientific American.—*The Editor.* ●

"There is still another aspect of post-war business planning that particularly concerns the electrical industry. We are proud of our war job with its vital production of needed weapons and tools. But more so than most industries, we have undertaken war tasks which flow most naturally from our particular talents. Most of the things we are making are electrical in character, and have to do with the generation, use, and control of electric power. Many of them are as applicable to peacetime as to wartime The majority of the thousands of new employees we have taken on have been trained in tasks that need not necessarily cease when the conflict is over Like most industries, we are acutely aware of the obligation which these added plants and added personnel imposes upon us, but we feel that we have a better-than-ordinary chance to keep them going afterwards

"This industry has always had to face the so-called 'impossible'," said Mr. Wilson, "to seek an outlet for its talents and abilities beyond the horizon by means of original research and application Our products, by and large, have not worn out; they have been made obsolete by the ambitions of scientists and engineers long before that. Therefore, to plan for the future is no new task. It seemed only natural that we should, from the beginning of the new world war, lay particular stress on the reconstruction years in our thinking and planning.



Charles E. Wilson, General Electric: "Any plan for 'day after tomorrow' has to find its seed in yesterday"

"Many months ago the General Electric Company set in motion a planning committee whose task it is to look into the laboratories for new ideas, to make preliminary surveys of potential markets, to inventory machines and plants and personnel. This was no visionary undertaking, and the detail in which some of these blueprints of the future operations have been drawn would surprise many outsiders.

"Complete as our plans may be," revealed Mr Wilson, "we are aware that no one company, no single industry, can bring this off alone. It will require a broad and united effort on the part of all business. It will need an understanding of the risks involved for private enterprise, for we must gamble our bluest chips to ward off depression and economic chaos. We cannot sit back and be conservative and reactionary but must be prodigal with our time and our resources and our courage. Not only business is involved, but government and labor and agriculture as well. Because the scope of such an effort must be broad, we have tried to promote an interchange of ideas on planning and to set a good example.

"The pressure of war is tremendous, and its brighter side is that it has telescoped years of progress into months. Just as radio was a by-product of the last war, the plastics industry on a large scale seems to be a by-product of this one. It has been forced into an adult stage by government demands and the scarcity of other materials. Electronics has made similar progress. Electricity will play a giant's part in the growth of the building industry after the war. On the one hand, consumer wants for the products of better living are being stored up, and on the other hand, those products are being improved by war-born knowledge. Any one can picture the post-war possibilities in aviation as a result of the new devices and instruments and controls developed for bombers and pursuit planes. The food we eat will be more nourishing, more plentiful, and better preserved and prepared as a result of work now going on.

"Fortunately, intelligent planning is a state of mind and not an activity which requires the labor of many men," concluded Mr. Wilson. "It is not inconsistent with maximum war production and need not get in the way of that all-important job. Yet it is tied to it as surely as tomorrow is tied to today. A mere handful of thinking men can ride the crest of research, development, engineering, manufacturing methods, and fundamental economics and shape a working plan for tomorrow. It may not be perfect and it is forever subject to change—but it is a plan. With it we need not face the future empty-handed and confused."

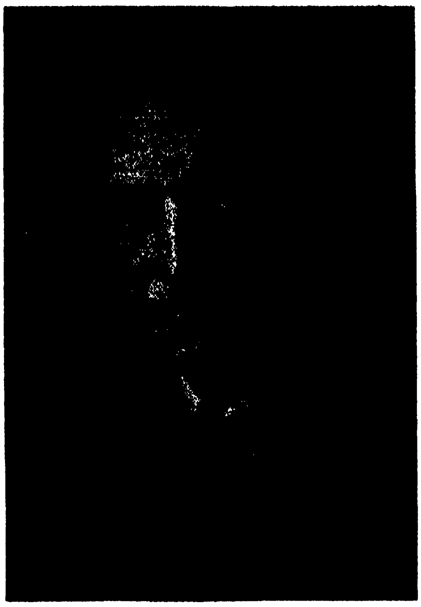
Representative of the motor-truck industry is The White Motor Company, one of the country's largest manufacturers who are building motor vehicles for the armed forces—and at the same time learning many things that will be applied to the civilian motor truck of the future. Mr. F. T. Macrae, Jr., Executive Vice President of White, painted the following verbal picture:

"America recognized a long time ago that it might be drawn into the present conflict and it started marshalling its engineering and inventive genius to the task of turning out superior weapons. As evidence of work well done, we have highly efficient planes, tanks, trucks, and guns coming off the production lines today. With the best of equipment we will achieve victory—a victory with marked benefits for the peace-time era to follow.

"Not the least of the benefits to be derived will be the contribution of war tools to peace-time equipment, and certainly the influence will be most noticeable. Engineering and material progress has been so revolutionary that we can expect vast changes and improvements in many fields of human endeavor after the war is over.

"Quite naturally, the automotive and aeronautical fields will make use of the many developments precipitated by national defense," continued Mr. Macrae. "It is safe to say that some of these developments would have required 50 years or more without the driving force of war. Let us look at the strides we have made in the light of future significance.

"In the first place we have developed airplane engines of almost unbelievable power-to-weight ratios. This not only means far more efficient commercial airplanes in the future, but it means more efficient trucks, buses, and automobiles as well. Certainly the automotive field will inherit a great many things from aviation. As a matter of fact, some companies had already examined aeronautical standards before the war and had made better automotive products because of it.



F. T. Macrae, Jr., White Motor Company: "The finer, lighter, and stronger materials born in this war will serve as the basis for new industries when peace is declared"

"The White Motor Company went whole hog in adopting an airplane-type, air-cooled engine for its White Horse retail delivery unit as developed three years ago. And because of it, the company was able to boast unusual efficiency and economy of operation. White also took a tip from airplane design when it developed the Super Power engine for heavier duty units, thereby getting more power with less weight. But all this occurred before the present emergency period. The effect of World War II will be almost unlimited.

"For instance, farmers living in the vicinity of army camps have already witnessed the ease with which Half-Trac reconnaissance vehicles whisk across muddy fields and swamplands. And the question comes up: 'Why can't I get a vehicle like that for working my lowland acres?' When the war is over, that question will find friendly ears and designers will go to work to produce a domestic vehicle with all the operating advantages of the military unit.

"The Half-Tracs, as developed by White in collaboration with the United States Army Ordnance Department, are supported in the rear by a tractor belt. This gives them tremendous traction power on any kind of ground. With a wide range of gear ratios, these versatile units can vary their speed from a slow crawl in difficult spots to 50 miles an hour on hard ground or highway.

"This is but one example. Actually, the new tanks, planes, gun carriers, trucks, and other equipment will have a profound effect upon post-war operations. Soldiers home from the army will not forget the efficiency of mechanized military equipment and they will demand machinery of comparable efficiency for their peace-time work.

"When we look back, we can realize that World War I was the real birthplace of the airplane. When that conflict was over, commercial aviation came to the fore by leaps and bounds. Even the truck got its real impetus from that war. Obviously, where problems are forced upon us and competition adds its challenge, great things can be expected.

"The business world is already looking beyond the present conflict to the needs of the post-war period when defense employment gives way to domestic employment," concluded Mr. Macrae. "Certainly the finer, lighter, and stronger materials born in this war will serve as the basis for new industries when peace is declared. And the path of design, dictated by war-time progress and invention, is a guarantee that radically new products will make their bid on the active market to come. In the same way, we can be sure that our present all-out production effort will leave its impression in the way of new and better manufacturing methods."

And now a few words from the petroleum industry, as represented by Gulf Oil Corporation. Here the statement obtainable was short and rather evasive, but understandably so in view of the manner in which the oil industry finds itself at present between the devil and the deep-blue sea. Here is what Mr. C. H. Hathaway, Assistant to the President of Gulf, has to say:

"We are, of course, bending every effort in all divisions of our business—production, refining, and marketing—that will aid in the successful prosecution of the war. This includes research in all of its various branches.

"It is both natural and inevitable that along with this we are gaging our sights, so far as we can look ahead, in anticipation of the conditions that will prevail in the following days of peace. Rightly enough, many of the things that war research and war planning are helping us to discover will not be without some benefit in the post-war period. Already we know this to be true. New and better products for the public and for industry must be one of the peace-time goals—products that will meet demands which in many cases may be quite different from those of the past."

While everyone may not consider agriculture to be an industry in the generally accepted sense of the word, it is so rapidly assuming that status that some consideration of it must be given in any survey which attempts to anticipate the possibilities of winning the peace after the war. We therefore give the following quotations from a speech by Secretary of Agriculture Claude R. Wickard, presented at the Second Inter-American Conference of Agriculture in Mexico City.

"There will be need after the war for some of the stocks now piling up in this hemisphere," said Secretary Wickard. "European agriculture has been disorganized. There is starvation in occupied Russia, Greece, and Poland, serious malnutrition and undernourishment in every country Germany has subjugated. When this war ends, there will be immediate and desperate need for relief. The food supplies of the Americas can win the peace as well as the war.

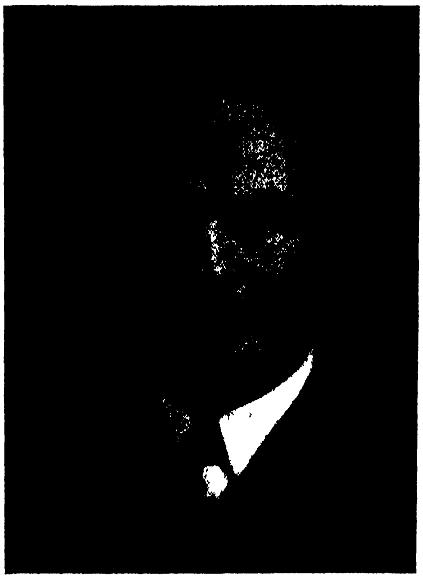
"In the United States we welcome the changes in our agricultural plant which the war has compelled, for we believe the result will be a sounder agricultural economy. Many people of our nation have never eaten enough meat, milk, poultry, and fruits. There has been malnutrition, as in every other country of the world. I have seen similar reports prepared by Argentine, Bolivian, Ecuadorian, Colombian, Canadian, and Cuban nutritionists.

"The war now compels us to produce more of the very things our people most need. After the war our task will be, not to adjust production downward, but to find ways of distributing our maximum production to our people. Well-planned introduction of new crops to our hemisphere will give us more purchasing power, higher living standards, and a better basis for reciprocal trade.

"There is no serious contradiction between intensive war production and our desire to establish a sound post-war economy," continued Secretary Wickard. "Indeed, there would be little point to winning the war if we did not have positive plans and ambitions for the future. We are not so complacent about our pre-war way of life as to look forward only to its restoration. Few people of our nations would wish to fight for a return to unemployment, poverty, and hunger. Our fighting strength will be immeasurably greater if every man and woman of every nation has a stake in the war, and sees in victory a step toward a better world.

"We may expect other problems as a consequence of war. We are now beginning production in this hemisphere of crops such as rubber. What will our position be when other parts of the world can resume production and export? Some people have suggested that we cannot hope to compete with these areas because of the low wages paid there, and that continued production of such crops will have a depressing effect on real wages in this hemisphere.

"I do not regard that problem as impossible of solution, nor do I think we can permit it to deter our production efforts. First of all, we do not know what the post-war demand will be; the needs for rubber, metals, and other items may continue at better than pre-war levels. Further, there will be a period of adjustment, since other parts of the world cannot possibly resume full production as soon as the war ends.



Claude R. Wickard, Secretary of Agriculture: "The willingness of free people to fight for a better future is the strongest weapon . . ."

"The real question, of course, is cost of production. The scientists and technicians may strengthen our competitive position by better production methods, higher yields, mechanization, improved transportation, and new processing techniques.

"Both for the present and the future, the United States Department of Agriculture offers to the representatives of other nations, and especially the nations of the Western Hemisphere, the services of its scientists, economists, engineers, and technicians, and the facilities of its laboratories and experiment stations. The United States Department of Agriculture has sent specialists to a number of countries to help solve livestock problems, cropping problems, economic problems, and problems of insect and disease control. Last year we sent a group of soil conservation experts to one of the southern nations to survey the agricultural land and recommend a program of soil protection and improvement. The men returned to the United States praising the co-operation they had received and the great foresight of the agricultural leaders with whom they worked. We have agreed to furnish similar assistance to several other countries.

"We would like to see a greater exchange of agricultural students between the United States and the other American countries. Young men from several South and Central American countries are now in the United States studying our rural electrification program. Other young men are studying our soil conservation program by working on the land with technicians of the Soil Conservation Service. Still others are being trained in agricultural economics by the Bureau of Agricultural Economics, and a number have accepted scholarships in agricultural chemistry and engineering. We hope these training programs will be expanded. I think there is still much to be done to promote the exchange of information and ideas. The Inter-American Institute and the new experiment stations will provide new opportunities for American scientists and technicians to combine their knowledge and skill.

"Together we can map out a future for agriculture, a future of progress and economic well-being," concluded the Secretary. "We can offer to our peoples and those of other lands a better way of living. In fact, we must do so, for our war effort depends upon it. The willingness of free people to fight for a better future is the strongest weapon of the United Nations."

From agriculture to tool engineers is the next and last step in this survey. The skill and ability of America's tool engineers which have made possible the rapid conversion of industry to war production will, in peace time, bring to America mass-produced commercial planes and a new type of automobile with a much smaller and higher compression motor, according to Frank W. Curtis, Chief Engineer, Van Norman Machine Tool Company. Jigs, fixtures, dies, and other forms of special equipment, the products of tool engineering, are the measuring stick of success in modern industrial war production, instead of being merely the overhead evil they were formerly considered, Mr. Curtis declared, and continued:

"The war efforts have resulted in the development of processes and products that otherwise might have been delayed. After the war, it will be another problem for the tool engineer to make it possible for these discoveries to be applied and made available for public consumption.

"Automobiles and airplanes are two outstanding products that will derive the benefit of scientific research and thus create a vast number of changes in our way of life. Just what the automotive engineer will do after the war is still a secret, but it is safe to assume that the industry will be reborn, as will many others.

"America's increased capacity in the production of aluminum and magnesium will bring about a tremendous expansion in the use of light metals for automobile uses. These metals will, no doubt, compete with steel for many purposes. Plastic materials will be available in larger quantities than ever, and automobile bodies of plastics are quite possible to conceive. Plastics capable of withstanding heavy blows are already available for many war uses and will find even more uses in peace-time.

"A refined gasoline many times more powerful than our present fuels has been produced, which will require entirely new automobile engines because present designs are not able to use it. This fuel is of a very high compression type that will require a small, high-speed motor with greater power per pound of weight than present motors.

"Since airplanes depend on lightweight motors, these engines will probably be used in the larger number of small planes that will be produced after the war, so that a new era of civilian flying can be expected, especially with the thousands of army and navy trained pilots who will want low-cost aircraft of their own. The rapid strides made in the building of warplanes have been made possible only under war emergencies, where speed has been so urgent. The mass-production methods will carry over to peacetime, so that we may expect the air to rival the road as a means of travel.

"Tool engineering has had an enormous effect upon nearly every phase of the advancement of civilization," Mr. Curtis explained. "The cost of automobiles, refrigerators, radios, and many other products would have been far beyond the reach of the average man if it were not for the science of tool engineering. Not many years ago, interchangeability of parts was considered an expensive undertaking, limited to the manufacture of products in exceptionally large quantities. Today, however, through the close study of manufacturing methods, almost any type or style of product can be made interchangeably, even though the output may be considered relatively small.

Frank W. Curtis, Van Norman Machine Tool Company: "After the war it' will be . . . for the tool engineer to make it possible for . . . discoveries to be applied"

"During the past few years management has learned that tool engineering is the backbone of successful manufacture. Not so long ago, however, some executives were not too familiar with the so-called hidden advantages of 'tooling', and looked upon special equipment as some kind of unnecessary overhead that merely 'cost a lot of money.' Today, the picture is quite different. 'Tooling' has become of vital importance, and management realizes how necessary it is to tool-up adequately to meet production demands within stipulated costs.

"Those engaged in the field of tool engineering know, perhaps better than anyone else, that tooling cannot be valued by its cost. Cost is a factor, of course, but performance is what counts and what we must attain if our tooling is to be succesful. Let us not forget that more can be accomplished with highly specialized tooling in a machine tool of an earlier model, than through the use of a most efficient and modern machine with inadequate tooling: something that could be likened to 'hitching a race horse to a plow.'

"When a design or an idea is born, we should first look to the tool engineer to offer his final analysis of whether or not the product can be successfully made. In plants where this practice has been adopted, the tool engineer has the opportunity to analyze the product from a production viewpoint, and without any selfish motive whatever can be very instrumental in showing how certain changes and modifications can be made to eliminate expenses and costs which might otherwise be overlooked. Often the product can be picked apart, piece-by-piece, enabling redesign, if necessary, to conform with modern day manufacturing practices.

"We should always remember that the design of a product is one thing, and the method of making it is another," concluded Mr. Curtis. "Both must tie in with each other, because any product, no matter how efficient it may appear, is no better than the tools used for its manufacture. The tool engineer, therefore, is as important in our industrial cog as the designer, who is called upon to develop a product, because without tools and a means of producing economically the most needed type of product would be restricted."

Thus, as Mr. Curtis so ably points out, the part of the tool engineer in shaping the future of the world is more assured now than ever before; the more rapidly tools can be produced, the sooner industry can turn from one product to another, from a crude design to a perfected unit, from old styles to new. Such rapidity of changeover, with resulting economies, will be an essential in the shift from war production to production for peace

Upon such men as those quoted in this survey depends the future of industrial America, a future that will be assured in proportion to the speed and efficiency with which these same men complete their war-time production job. Their mental processes have been sufficiently revealed here, it is believed, to demonstrate beyond doubt that, given an even break to apply their know-how, the men of industry in the United States will do more than their share toward winning the war. Once this is accomplished, they will plunge just as enthusiastically into the winning of the peace, prepared for the work of tomorrow by the foresighted planning that was a continuing process during the war-clouded times of today.

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SILVER LININGS

Are Being Proved

Industrially Practicable

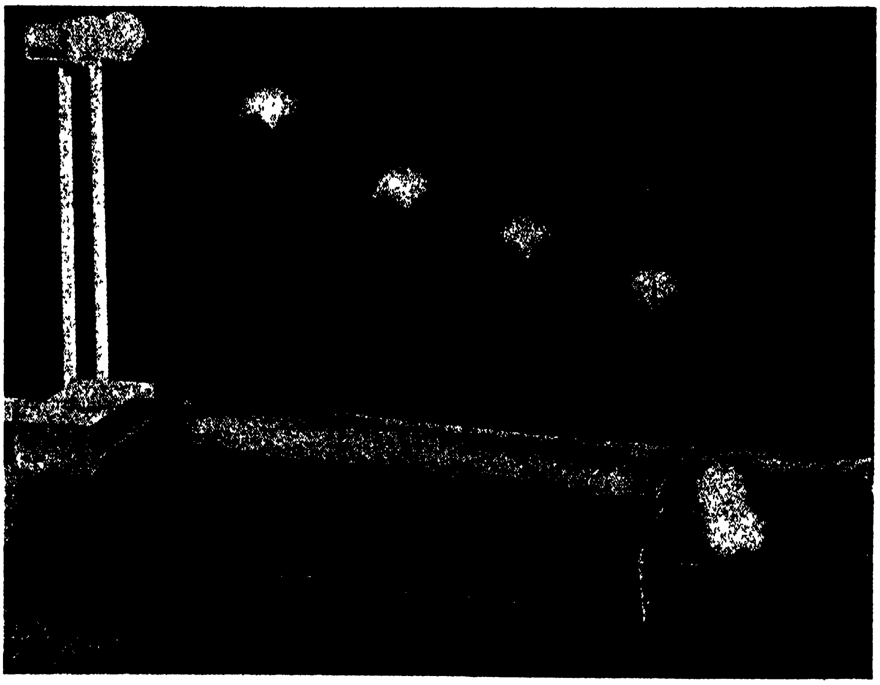
The present-day tin can has been and continues to be a satisfactory metallic container for a vast number of purposes. Today, however, although we are faced with a dire shortage of this seemingly indispensable coating metal, we have at hand another metal —silver—which can be substituted for tin as a container lining with the outstanding advantage that it is resistant to many products which attack tin.

Silver is resistant to alkalies, organic acids, and certain concentrations of hydrochloric and other mineral acids. Most organic silver salts are free from color, thus eliminating the objectionable discoloration of contents, even though traces of the silver may be dissolved. For that reason, silver has long found wide use for a variety of equipment in chemical manufacturing plants. Silver is also bactericidal and may be used in contact with food, and may even be taken into the body in minute quantities without danger. Obviously, therefore, silver is eminently fitted for the linings of containers of such products.

Silver can be applied relatively economically to metal containers by electro-deposition on the sheet which can then be formed, soldered, and so on. It can be applied from the very thinnest deposits (0.0001 of an inch) up to very heavy thicknesses (0.05 of an inch) with equal facility It has also been deposited, under laboratory conditions, at very high current densities up to 200 amperes per square foot, thus pointing the way to reductions in the time of "dwell" in the electroplating bath to a fraction of common practice.

The cost of silver plating depends upon, among other factors, the weight of the silver deposited: cost, approximately 28 cents per square foot for 0.001 of an inch thickness. From this should be deducted the cost of the material which it replaces such as: nickel at 2.5 cents for the same thickness, copper at 1 cent, tin at 2.5 cents and so on.

Interest in the use of silver-lined containers may be judged from the fact that they are being considered seriously for such products as foodstuffs, high-grade beverages, beer, cola syrup concentrates, condensed milk, evaporated milk, salves and other antiseptic materials, ether, aluminum chloride, and other chemicals.



Failure to bounce indicated a way to progress in electrical relays

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BOUNCELESS BALL

Points Way Toward

Improved Electrical Units.

More positive operations of electrical relays—delicate, swift-acting switching devices which are used in communications systems—is now being assured as the result of experiments with bounceless balls. Engineers have found that a steel ball half filled with metallic powder will not bounce, as proved by the time exposure photograph reproduced in these columns. During the exposure of this photograph, two balls of the same weight—one empty and one containing powder —were dropped simultaneously from the top of the posts. The empty ball left a looping trail of light as it bounced on the steel plate, but the ball containing the powder rolled without bouncing. Rough surfaces of the metal powder particles, engineers explain, created frictional heat as they slid over each other, dissipating the energy which the ball would have used in bouncing.

The knowledge obtained by these experiments has been applied to relays in which contacts are made in hollow form and partly filled with powder. This eliminates bouncing and chattering of contacts In some special cases, hollow powder containers are attached to the contacts for the same purpose.

MOISTURE IN WOOD

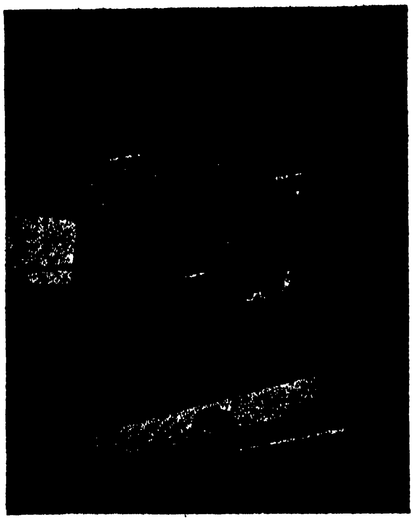
Determined With New

Electrical Instrument

Speedy and accurate determination of moisture content in wood, by the dependable electrical resistance method, is now possible with a simple, moderate-cost instrument which supplies direct readings in moisture-content percentage terms With such an instrument it is possible to meet various specifications covering the precise condition of lumber, as called for by the Army, Navy, F.H A., critical architects and builders, lumber mills and dealers, furniture manufacturers, railroads, public utilities, and others.

This simplified wood-moisture tester, developed by Industrial Instruments, Inc, is a modified Wheatstone Bridge using a cathode-ray electronic tube as the null or balance indicator. The combination switch and control knob is rotated until the null indicator flashes, at which point moisture content is read directly on the dial. Since the bridge circuit is self-compensating, there are no variables to contend with or compensate for such as voltage fluctuations or varying tube characteristics.

The standard pin-type electrode furnished with the instrument will not permanently mar the surface of the material under test. It is readily driven into and extracted from the lumber



Indicates degree of dampness

or wood by the hammer-extractor furnished. Or if progressive checks on various lumber stacks are to be made throughout the curing period, leads may be soldered to properly placed and spaced nails, and tied into a panel board located near the instrument for periodic readings.

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LACQUERS—Until the development of quick-drying lacquers it was thought that lacquer finishes had to be slow-drying in order to be durable. Long-time tests of the quick-drying types have disproved this theory.

• • •

GUAYULE

Compounded with Synthetic and Natural Rubbers

Mounting demand for guayule rubber resulting from its widened use for compounding with synthetic rubbers has led to doubling the productive capacity of Cia Hulera de Parras, important producer of guayule, according to an announcement by American Cyanamid and Chemical Corporation, representative of the Mexican company. The increased capacity is being put in with the co-operation of United States government agencies.

Use of guayule, a type of rubber derived from a Mexican shrub thriving in semi-arid regions, has in the past been small because of its high content of resin, which is undesirable in rubber. Present rapid extension of its use is based on the improved properties which guayule (containing its original resin) imparts to synthetic rubbers, particularly of the Buna S type. Guayule serves not only as an additive and extender for the synthetic, but at the same time it increases the adhesiveness or "tack" of the product, an important property in working the synthetic.

Aside from the decided benefits of compounding guayule with Buna S and other synthetics, its use in increasing amounts for compounding with natural and reclaimed rubber in many applications is urged to extend the life of our dwindling stocks of natural rubber.

PATTERN PLATES

Made from New Board Which Saves Metals

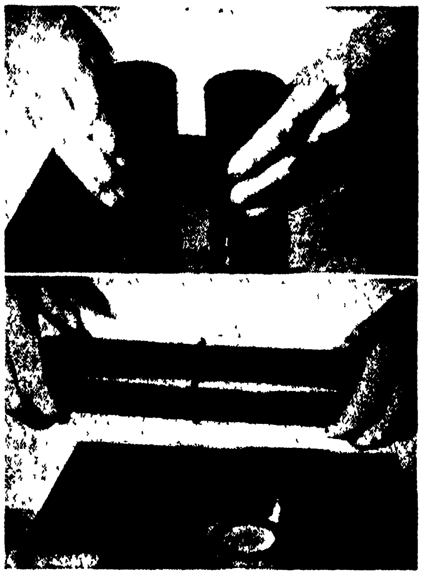
A laminated plastic board which is available in a stock range of thicknesses is now being used for making pattern plates, as a substitute for aluminum or magnesium. The board, called Lignolite, does not warp, can be machined, and is impervious to moisture, oil, grease, and dilute acids. The surface of the board is designed to prevent sand from sticking to it and the stock itself has ample strength for pattern purposes.

PLASTIC PIPE

Has Many Applications to Replace Strategic Metals

A new plastic pipe, manufactured in the same dimensions as extra strong steel pipe of two-inch outside diameter or less, has properties of resistance to extreme moisture, chemicals, and solvents, coupled with high strength and long fatigue life. It is entirely unaffected by water, and only a few solvents exhibit any adverse effects. In many applications this new plastic pipe will undoubtedly replace strategic materials, such as vital metals and rubber, and release them for more urgent needs associated with the war effort.

This new pipe, developed by The Dow Chemical Company, is made of a new thermo-plastic resin known as Saran. The base resin is odorless, tasteless, and nontoxic. The plastic does not burn and its toughness and abrasion resistance are of a high order, the retention of these properties on aging insuring excellent wearing qualities. This pipe is non-scaling and withstands freezing. Heat resistance is said to be excellent up to 175 degrees, Fahrenheit.



Hot-plate welding of plastic pipe

Saran pipe is produced in smooth, round, accurately sized lengths having dimensions identical with those of strong iron pipe. It can be readily welded, heated, and bent. The pipe can be cut with a wood or hack saw and threaded with ordinary iron pipe dies.

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INDUSTRIAL TRENDS

CHEMISTRY IN THE FUTURE

EVERY so often it is needful—and stimulating—to lift the lid of the chemical industry and see what's cooking. Much of the cooking, of course, is shrouded in the steam of military secrecy, yet enough is visible to serve as an indicator of what is going on within, and, therefore, as a key to general trends.

Regular readers of Scientific American have been able to follow in our monthly issues the story of day-by-day developments within the chemical industry. Spread over a period of time these developments often lose significance, a loss which can be recovered only by bringing the whole picture into clear focus and examining for general trends those phases which, at the moment, appear to hold the greatest promise for the future.

Such focusing was so ably accomplished recently by Dr. Charles N. A. Stine, Vice-President of Du Pont and its advisor on research and development, at a meeting of the American Chemical Society, that we can do no better than to skim the highlights of his address and let the shadows fall where they may.

Emphasizing that the war is compressing into the space of months developments which might have taken half a century for realization if necessity had not forced the pace, Dr. Stine said: "These pressures are unprecedented. Give us a victorious peace and the freedom of enterprise it should grant, and our progress will be unprecedented."

Some of the progress which has already been traced and which will be reflected in the trends of the future were enumerated by the Du Pont chemist. Aluminum production, for example, will be such by the end of 1943 that enough metal will be produced in one year to build three times the number of passenger cars now operating on our American railroads.

Petroleum chemists of today see existing motors as out of date, as a result of the war pressure to create better fuels for airplanes. In the same field, it is noted that the new motor-car models that are gathering dust in dealers' storerooms have aged technically at least two decades since they were manufactured. For example, the chemists have collaborated in the development of sealed cooling systems, now used in aviation, which will undoubtedly be applied to the automobile of the future. Power per gallon of fuel will increase, and fuels will yield much greater mileage.

In the field of plastics there will be available, after the war, the most versatile of materials on a scale beyond all previous comprehension The high-pressure synthesis of ammonia, one of the major chemical exploits of the century, will so boost the production of fertilizer chemicals as to change completely the basic trends of agriculture.

Then there are such things as unbreakable glass and glass that floats, wood that won't burn, and laminations of plastics and wood that are competing and will compete even more with structural metals. Nylon, derived from air, water, and coal, one of the wonders of pre-war days, will be but a forerunner of many innovations from the same source. These new products will range from shoes that contain no leather and window screens that contain no wire to machine bearings that contain no metal.

In still another field there is magnesium, a structural curiosity only a few years ago, which today enters into the construction of every fighting airplane that is built. After the war it is now estimated that the nation's capacity for producing this lightest of all structural metal will be more than double that of the aluminum output of 1939.

In the rubber field, the United States alone, declares Dr. Stine, is now undertaking to accomplish, synthetically, in less than two years, the manufacture of chemical rubbers to a degree which, in the natural rubber field, required more than a century of development.

Many other new things are coming from the chemists' test-tube for use in the post-war world: New fabrics for clothing, steel that will challenge the new light metals, things to be made from the chemical building blocks of hydrogen and carbon that come out of the thousands of chemical compounds in every barrel of crude oil, new homes made inexpensively of new materials and painted with new paints, developments in medicine which may eventually outweigh even the staggering losses of this World War, and so on.

Here indeed is a heartening picture of the chemical industry as a whole, painted by one of its ablest members. From such a picture can be gleaned an assuring view of the future possibilities of this esoteric industry which holds such tremendous possibilities.

WELDING AND CUTTING

ONE of the hottest flames produced by man—at a temperature of some 6300 degrees, Fahrenheit—is being applied in many ways to aid forced-draft war production of fabricated metals in many forms. This flame, furnished by the oxy-acetylene torch, can weld metals together in a joint stronger than the metals themselves, can cut many metals apart in a fraction of the time consumed by other methods and with a minimum of loss, and can be used to surface-harden or to clean metal surfaces preparatory to painting and similar operations.

These lines are not intended to detract from the value of electric-arc welding, but rather are written to clarify the oxy-acetylene situation, to point out the uses of this versatile flame, and to indicate general ways in which these uses will extend into the future.

None of the welding methods in use today is exactly new, except in refinement. These refinements, and mass methods of application, however, have meant a tremendous speeding up of many industrial processes. Welded ships probably symbolize most graphically the construction methods using welding which are speeding the war effort. Within these ships, also, are found other products of the oxy-acetylene torch—metal sheets and plates of various thicknesses cut to exact sizes to fit the spaces assigned to them. These sheets have been cut—often in duplicate—by the same gas flame that later welded them together in an unrelenting embrace. So accurate is the cutting flame, in fact, that complicated machinery has been designed to guide the flame as the operator follows a pattern; many such machines use multiple torches to speed up work, or one torch may be used to cut a series of plates stacked one on top of the other.

Then there are methods of surface-hardening metals using the oxy-acetylene flame to heat the surface, which is then quenched by one of several means. Lastly, the same flame will clean surfaces of rust, paint, scale, and so on

We have heard much of this industrial tool during the war speed-up; we will hear more of it in the future.

—*The Editors*

Portentous Eclipse

The Recent Eclipse of the Moon, an Odd One, Afforded Astronomers More Fun than Usual

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

GREAT numbers of people must have watched the eclipse of the Moon on August 26th. Observing conditions, in this part of the country at least, could hardly have been better—a brilliantly clear night with the eclipse coming on in the evening and at its maximum a little before midnight (more than an hour before, were it not for "war time") so that the eclipsed Moon, despite its southern declination, was well up in the sky. The writer, who has seen a good many lunar eclipses in his time, wonders how many of the thousands of watchers realized that they were beholding something so unusual that, to the experienced eye, it seemed to be almost what the ancients called a "portent."

The early stages of the eclipse passed off as usual—the dimming of the eastern edge of the Moon by the penumbra, or half-shadow within which the Earth hides part but not all of the Sun; the "bite" out of the Moon's edge as the actual shadow—the umbra—enters upon it; and the gradual realization that this shadow is not completely dark, but that the eclipsed part of the Moon is faintly visible.

As the Moon swept deeper and deeper into the shadow, one noticed, as usual, that this illumination was fainter and redder in the inner part of the shadow-circle than near its edge. Then came the surprise—the upper right-hand edge of the Moon became much fainter than the rest. The dark area spread and, near the middle of totality, the Moon looked as the writer, at least, has never seen it before—with dark center and a light ring all around its periphery. Then the eastern edge slowly brightened, and the dark area moved toward the western side as the Moon passed away from it toward the light.

The faint reddish illumination of the eclipsed Moon is normal: but the presence of a relatively small and conspicuously darker spot within it is so unusual that the effect was uncanny.

Like all other "portents" in the heavens, it has of course a perfectly natural and fairly simple explanation—which, this time, demands only the drawing of a few diagrams.

Figure 1 represents the general circumstances of a lunar eclipse. It is very far from being drawn to scale. The Sun is about 50 times bigger and several thousand times as far off in comparison with the size of the Earth: but it illustrates the geometrical relations none the less. Since the Sun is larger than the Earth, the true shadow, or umbra, of the latter from which all direct light is excluded is a cone (shown in cross-section on the diagram) which tapers to a point *P* lying about four times as far away as the Moon's orbit. Outside this is the widening cone of the penumbra—shown by dashed lines—from which part, but not all, of the sunlight is cut off.

IF the Earth, like the Moon, was a naked body without atmosphere, the umbra would be entirely dark, except for the very faint light of the Sun's extended corona, and the eclipsed Moon would be invisible. Close to the edge of the umbra where, for an observer on the Moon, the inner corona and perhaps some prominences would be visible, there might be illumination enough to make a ghost of this part of Moon show up against the dark sky. But with the Moon near the center of the shadow all the brighter part of the corona would be hidden by the Earth and there would be nothing to see.

The Earth's atmosphere, however, being denser near the surface, acts like a lens and refracts the rays of light which pass through it inward from what would otherwise be the dark shadow, lighting it up feebly; and it is by this refracted light that we see the eclipsed Moon—as is illustrated in the figure. Rays that have just grazed the surface of the Earth are deflected inward by about 68'—far enough to carry them a little beyond the Moon's center, even when it is nearest, but not enough to take them to its opposite edge; which, however, will receive sunlight that has come close to the other side of the Earth, as a glance at the figure shows. To be deflected to the center of the umbra, at the Moon's surface, the sun's rays must pass within about a mile of the Earth's surface. A deflection of half this amount demands that the rays shall pass less than five miles above sea-level; rays with a minimum altitude of ten miles will be deflected by about one seventh of the angle to the center.

Now rays which pass as close to the surface as the first of these have a long path through the atmosphere. Even with the clearest air they are greatly weakened by the scattering of light out of the direct beam. This affects the short waves most, and results in the redness of the setting Sun, as well as the faintness of its direct light.

If the Earth's atmosphere was perfectly free from clouds and haze, the Moon, at the very center of the shadow, would still be faintly illuminated by light of the quality of a clear sunset. An observer on the Moon who happened to be for this moment at the central point of the umbra would see a narrow brilliant line of light, completely surrounding the huge disk of the Earth, and colored as the setting Sun looks to us in the fairest weather. As the Moon's motion carried him off-center, this ring would grow fainter on the side where the rays were most deflected, and soon disappear; but on the opposite side it would grow wider, brighter, and not so red—since the rays which formed it had traversed fewer miles of air and been less depleted, so that the total illumination in this vicinity would increase.

A TERRESTRIAL observer, viewing the Moon under these conditions, would see it feebly illuminated—faintest and reddest at the point corresponding to the geometrical center of the shadow—and gradually grow brighter and less red in regions remote from this. The graduation of this illumination would be smooth, with no dark patches in sharp contrast—and this is very much what is usually seen during a lunar eclipse.

Suppose next that, all around the Earth's edge, as seen from the Moon at the time of eclipse, the weather was bad, with clouds and haze piled to a depth of four or five miles. The light which would otherwise have been directed into the inner parts of the umbra would be blocked by these clouds. In the symmetrical, but exaggerated, situation which we are imagining, no light at all would enter the central part of the umbra. If a screen three times as big as the Moon could be set up, just behind the Moon, to show the whole umbra at once, we would find the outer parts of it illuminated much as usual, but the inner region black and big enough, in the special case which we have assumed, to hide the Moon completely.

Actually, of course, the weather will not be clear everywhere along the 25,000-mile belt of the Earth's surface along which the sun's rays graze it at the time of mid-eclipse, nor will it be cloudy everywhere. If the clear and cloudy regions are distributed at random along the belt, our imaginary lunar observer will see the ring of light surrounding the Earth interrupted in many places and the illumination of the surface will be weakened: but this weakening will be general all over the Moon's surface, with no conspicuous bright or dark spots. But if the clouds are localized in one region extensive enough to cover a considerable area of the Earth's edge as seen from the Moon, the illumination of the side of the umbra toward this area will be cut down, while that of the rest will be normal.

We have then to ask what distribution of clouds will account for the remarkable dark patch. The best way to answer this is to draw a diagram of the actual situation at mid-eclipse, which is shown in Figure 2. The large circle represents the umbra, as it would have been projected on a screen just behind the Moon, and the smaller one the Moon itself at the middle of eclipse — 11:48 P.M., Eastern War Time. At this time the Moon was about 11′ north of the center *C* of the umbra. At about this time (the writer unwisely failed to keep a note of it) the dark spot in the shadow was very nearly central on the Moon's disk and of roughly the size indicated by the dotted circle. It was therefore far out of center in the umbra, and the light which failed to reach it evidently did so because it found obscuration along the region of the Earth's edge indicated by the arc *AB* in the figure. At this time the Moon was overhead at a point in longitude 56° West, latitude 10° South in central Brazil, and the Sun at its antipodes in the China Sea West of the Philippines; and the circle half way between them, along which the Sun's rays grazed the Earth, ran from the Black Sea across the upper end of the Baltic, near Spitzbergen, across the northern edges of Greenland and the Arctic Archipelago, down to British Columbia, and into the Pacific about half way between California and Hawaii. All along this line, from Norway far into the Pacific, the weather must have been bad, or, at least, cloudy.

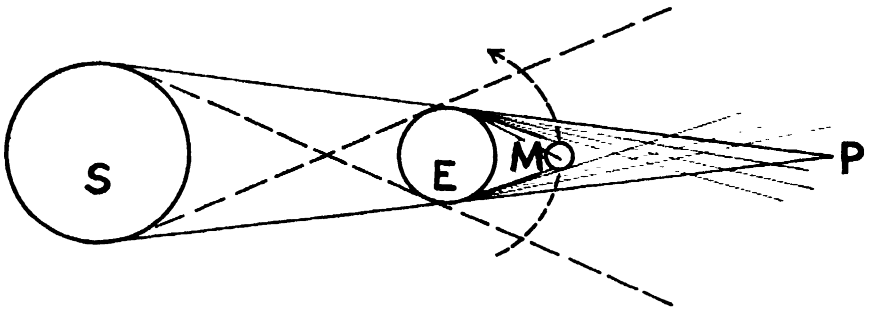

Figure 1: See the text

When the dark spot extended farthest from the center of the umbra, it reached nearly half way to its boundary. To produce so great an obscuration, the clouds above the Canadian shore of the Arctic Ocean must have extended to a height of about four miles—which is a reasonable enough figure.

Above Antarctica, on the contrary, the air must have been very clear, for on the Moon's limb, south of the center of the umbra, the illumination was fairly strong.

Just what distribution of open patches between clouds let in light enough at the edges of the obscured region to make the dark spot so nearly circular would be hard to figure out—especially as the problem probably admits of many solutions.

But it is evident that all that the weird celestial portent meant was that the weather was bad somewhere else.

There may still be romancers who may argue that the thing had something to do with the war. If such folks are amenable to reason at all, they may be recommended to consider that the region in which the obscuring clouds occurred is about as remote from military activity as any part of our planet, except the Antarctic where conditions were quite different.

The brightness of the eclipsed Moon is one of the few astronomical phenomena which is really unpredictable. Some day, when men know far more about the weather than they do now, they may be able to predict in advance how high the clouds (if any) will be in the Arctic and Antarctic — but, considering the complexity of atmospheric circulation, this seems very remote. Meanwhile, it is of interest to note that this unpredictable phenomenon is not only observable from the Earth, but that it would easily be observable and perhaps more easily measurable from Venus or Mercury, provided that intelligent inhabitants could exist upon them.

—Princeton University Observatory, September 3, 1942.

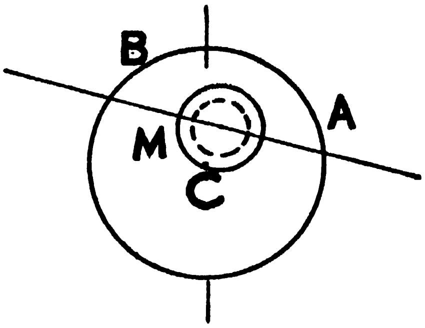

Figure 2: The situation

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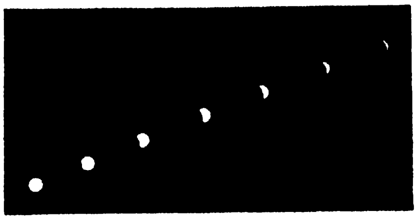


Part of the eclipse, photographed at 10-minute intervals (9:50 to 10:50 P.M., E.W.T.) by Dr. Henry Paul, Norwich, New York, amateur telescope maker. A series of eclipse photographs may be made with a camera, but the results will be disappointing. Without much difficulty a small telescope—say six inches aperture—may be rigged as a special camera to do a better job. In "Amateur Telescope Making," Harold A. Lower gives instructions for this. The image at the telescope's focus will be about half an inch in diameter, but it is so bright that it may be magnified by an eyepiece to about an inch and still be bright enough to photograph with an exposure of less than one second. The eyepiece is mounted in a simple box and a ground glass is used to determine the exact best focus. A plate in a plate-holder is then substituted and an assistant is posted in front of the telescope with a black cardboard, held over its front but not touching. The slide is removed, then the card is moved away edgewise and replaced as quickly as possible. If the exposure is short enough the image will not blur due to the moon's orbital motion. A clock-driven telescope will obviate these last difficulties.

Tunneling Under Difficulties

Part of the Delaware Aqueduct Was Drilled at Great Depths, Yet Was Finished in Half the Allowed Time

R. G. SKERRETT

Explosive gas and high-pressure water, stored in bedrock 400 feet below sea level, were the unforeseen obstacles overcome by the contractor in excavating a stretch of 75,000 linear feet of tunnel beneath a spur of the Catskill Mountains. That section of tunnel, the longest unit of the Delaware Aqueduct, will help to carry greatly needed additional water to New York City's more than seven million people.

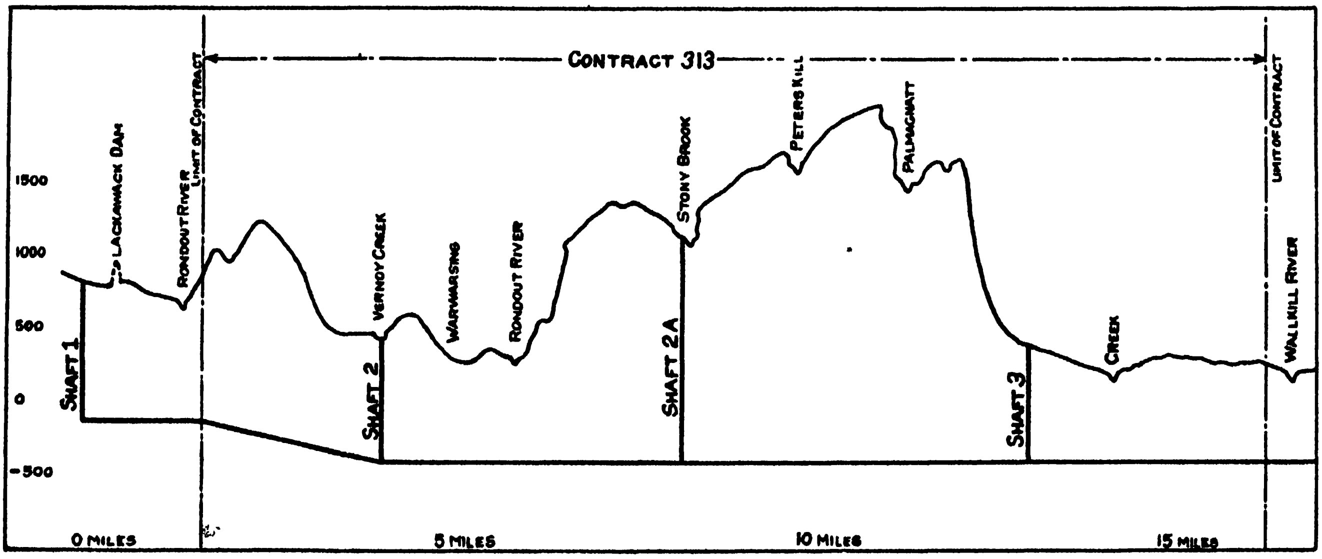
The engineers of the Board of Water Supply of that city designated that the tunnel should be driven deep in ledge rock, and that the conduit for the man-made river should have a finished diameter of 13.5 feet inside its thick concrete lining. At a depth of 400 feet below sea level, the engineers counted on finding sound rock to form the outer walls of a section of tunnel that would have to withstand a bursting pressure of 540 pounds on each square inch of internal surface. But Nature interposed difficulties.

Shawangunk Mountain, under which most of the more than 14 miles of tunnel passes, is a tremendous rocky mass that towers 2400 feet above the tunnel line and exerts an enormous downward pressure on the rock through which the bore has been excavated. When that mountain was shoved upward at some remote age, the previously horizontal layers of rock forming the earth's crust were bent, folded, and in places broken like a titanic jelly roll mishandled in the making. In time, great quantities of water and marsh gas—methane, highly explosive when mixed with ten times its volume of air—were stored in areas of the fractured and shifted rock.

Still another hazard existed. The tunnel had to be driven through rock that was under very heavy stress, like an enormous spring under compression. When tunnel-driving offered release for those pent-up forces, the rock in the roof of the tunnel and at the heading burst inward with explosive force. To prevent the "popping rock" from injuring the workers or damaging tunnel-driving machinery, about 90 percent of the tunnel roof had to be supported by a strong protective grid of structural steel members requiring the use of 40,000,000 pounds of that metal. The roof support reached to the very rock face, where a battery of pneumatic drills drove 40 to 50 holes, into which were loaded the shattering explosive charges. Before the last of the rock was broken through in this tunnel unit, the contractor, Samuel R. Rosoff, Ltd., had used 1550 tons of dynamite in opening up the 75,000-foot section of tunnel, generally excavated from 17 to 19 feet in diameter. One stretch of that tunnel that penetrates unusually difficult ground had to be excavated to 24 feet in diameter. It was while doing this latter work that the contractor had to battle long and strenuously against grave odds to work his way forward.

Prior to starting the driving of the long tunnel under Shawangunk Mountain, the Board of Water Supply had another contractor sink three shafts about five miles apart, along the tunnel line. (See the drawing.) The purpose of those shafts was to provide access later for the tunnel-driving contractor so that he could tunnel in each direction from the bottom of each shaft. Thus he had six points of attack which would help to shorten the time required in tunneling the whole 75,000 linear feet. The westernmost of the three shafts, Shaft 2, was sunk to a depth of 825 feet to reach the planned tunnel line. The central shaft, Shaft 2A, was sunk from a point high up on the western slope of Shawangunk Mountain and carried down to a depth of 1551 feet. It is the deepest of all the shafts on the Delaware Aqueduct. Shaft 3, near the eastern foot of the mountain, is 840 feet deep. The shaft-sinking contractor was required to drive 200 feet of tunnel, both north and south, from the bottom of each shaft to give the succeeding contractor space in which to set up his underground machinery for promptly beginning the main operation of tunnel-driving.

While driving the 200 feet of tunnel northward from Shaft 2A, some of the rock-drill steels penetrated a cav-



Route of the tunnel section described in text, showing depths, lengths, and shafts ity filled with compressed methane, and the released gas poured out into the tunnel heading from the rock face, mixed with the air, and in some way was ignited. The scorching blast that followed injured to varying degrees all 18 of the men at work. That was the first warning of what lay ahead for the contractor who would have to drive the long tunnel section. Experts of the United States Bureau of Mines promptly visited the scene and reported that it would be hazardous to continue underground operations unless means were provided for quickly disposing of all incoming marsh gas before it could form an explosive mixture with the free air in the tunnel. They specified that at no time should the marsh gas in the tunnel air exceed the trifling amount of 0.25 percent. Care was also to be taken that there should be no sparking of electric machinery, bare flames, or smoking.

The tunnel-driving contractor prevented the marsh gas from doing harm by employing an unusual system of tunnel ventilation. Near the top of each shaft, he placed large motor-driven blowers from which two metal vent pipes, each 28 inches in diameter, led down the shaft and thence, one each, to the opposite headings. At the rock face of each heading, a battery of pneumatic drills, mounted on a mobile drill carriage, drove holes deep into the circular wall, and into each hole a charge of dynamite was loaded. When all the holes were fired, the rock was shattered for a depth of 10 or more feet.

At the front of the drill carriage, top and bottom, were two suction intakes, each eight feet long and five inches wide—like gigantic vacuum-cleaners—that continually sucked away the air close to the rock face. The strong suction at those intakes—that picked up both dusty air and any marsh gas that might issue from the rock—was created by a powerful Roto-Clone blower mounted on the drill carriage. The blower discharged backwards through a fabric duct into the nearby open end of the big metal vent pipe, and the suction of the blowers at the top of the shaft drew the inflow speedily surfaceward and scattered it to the breeze.

The suction of the blowers caused a replacement flow of fresh air down the open passages in the shaft and then steadily onward to the headings. This stimulated circulation prevented any dangerous accumulation of any marsh gas in the tunnel sections and kept the air at all times remarkably clear and comfortable for the workers. Normally, in similar tunnel operations, ventilating blowers force air down through the vent pipes and to the headings; but such a course on the job under Shawangunk Mountain would have speedily distributed any marsh gas coming from a rock face and have increased the likelihood of a disastrous explosion.

The bulkhead that closed the heading of the tunnel against rapidly inflowing water. Lower left, at "A", is the first flanking drift that had to be abandoned. "B" indicates the seven-foot "barrel drift" which was eventually lined with 18 inches of concrete

The exhaust or suction method of ventilation made it possible to use Diesel locomotives, which previously were not permitted underground. The locomotives on this tunnel section have pulled heavy train loads of concrete for the tunnel lining at high speeds, thus hastening the work and shortening the time before more mountain water can be transmitted to New York City.

The resourcefulness of the engineers on this job was put to the greatest test in their battle with high-pressure water while driving the heading southward from Shaft 2. The gangs, working in three shifts of eight hours each, drilled, blasted, and removed the broken rock without cessation during each 24 hours. This work went on steadily for nearly seven months, during which the heading advanced a total distance of 6778 feet. Then scouting or exploratory drill holes, driven deep in the rock beyond the face, tapped water that flowed into the tunnel at an hourly rate of 24,000 gallons. Prepared for such a contingency, the men promptly moved special pumps up to the "firing line" and forced a mixture of cement and water—grout—into the hidden water-bearing limestone to arrest the inflow. It took 6000 bags of cement to bring the water under control. Tunnel driving was resumed and went ahead 175 feet, when another scouting drill hole again struck water that discharged forcibly into the tunnel. Once more grouting was used with some success; but shortly thereafter other exploratory holes increased the incoming water to 400 gallons a minute. Tunnel-driving was then halted lest a source of water be tapped that might inundate the entire tunnel section. The battle line had to be re-formed and strengthened to avoid sudden disaster.

The entire rock face of the heading was covered and sealed with a reinforced-concrete wall or bulkhead 10 feet thick; and, when water still came through the lower part of that barrier and the rocky floor of the tunnel at that point, the bulkhead was fortified with a supplementing wall of reinforced concrete 18 feet thick, reaching from the floor up to nearly half the height of the bulkhead. Through the total thickness of 28 feet of the combined barrier, four-inch steel pipes, embedded in the concrete, were used to guide drill steels in making the next exploratory drill holes; at the tunnel side each pipe was fitted with a valve that could be closed to shut off water that might issue from the rock when penetrated. The same pipes, with the valves open, could be used to

Inside the "barrel drift" with water coming in through still-open pipes. Through these same pipes drills were run and a special grout mixture forced under high pressure

force grout into the rock ahead at pressures as high as 1000 to 2000 pounds per square inch.

Gages attached to some of the drain pipes registered a water pressure of 290 pounds per square inch, indicating that the water entering the tunnel was in some way connected with Rondout Creek, the surface of which lay 650 feet above the tunnel itself. The creek water had worked its way through the ancient bed of Rondout Creek, 400 feet thick vertically and formed of sand, gravel, and boulders deposited when glaciers had covered the countryside. This water had continued downward through fractured and fissured ledge rock that had a thickness of not less than 260 feet and that lay squarely across the line of advance for the tunnel. Here was difficult and dangerous ground that had to be penetrated with a minimum of lost time if the tunnel were to be completed The methods that were used proved to be highly successful, although the first attempts at conquering the bad ground met with complete failure. But once more the engineers were resourceful and attacked the problem from another angle.

When grout, forced through drill holes to a distance of 70 feet ahead of the bulkhead, did not seal the water-bearing rock, a flank movement to sidestep the bad ground was made by driving a small tunnel or drift, eight feet square in cross-section, through the lower left-hand face of the bulkhead, to be used to try to consolidate the outlying water-bearing rock by grouting from that passage. When the inflow of water attained 2100 gallons a minute, after the drift was driven for a length of 87 feet, that excavation was abandoned and filled from end to end with concrete.

Before the drift was started, the engineers had erected a second line of defense in the form of a second concrete bulkhead 73 feet back from the bulkhead at the rock face. At the floor level and in the center of this bulkhead there was left a rectangular opening for carrying on operations, and that opening was fitted with a swinging door of massive steel that had an upper and a lower panel. It could be closed quickly, if needed, to prevent any sudden inrush of water sweeping back into the remainder of the tunnel. Large pipes, piercing the lower part of this bulkhead and fitted with valves, were to release water held between the two bulkheads and allow it to accumulate in a sump on the tunnel side of the barrier, where a group of pumps would pick up the water and send it onward to the bottom of Shaft 2. There another group of pumps, with a capacity of 9550 gallons a minute, raised the water up the shaft to ground level.

The final means adopted by the contractor's experts to get through the bad ground and to plug the water-bearing rock was a small tunnel—a so-called "barrel drift"—circular in section and seven feet in diameter inside its 18-inch lining of concrete. That tunnel had its center just below the axis of the heading. It was advanced in five stages, of different lengths, for a total distance of 226 feet, and the forward end temporarily closed with a concrete bulkhead six feet thick. One hundred days were required to make that progress.

As the "barrel-drift" went forward, grout was forced into enveloping rock, at each of the stages. This was done through radiating holes, arranged like the spokes of a wheel, drilled through pipes embedded in the concrete lining and arranged in a ring-like formation every four feet of the length of the small tunnel. Each ring had 14 pipes that could be closed with valves at their inner ends. The drill steels, because of the confined space in the drift, were progressively lengthened in jointed sections like some fishing rods, and their full length was great enough to penetrate 10 feet of the rock outside the final excavated diameter of 24 feet of this particular tunnel section

Grout of a special cement mixture was forced through the pipes and the drill holes of the "barrel drift" and into the water-bearing rock at a pressure of 2000 pounds per square inch, after each drill hole had been flushed with water at the same pressure to clear the way for the sealing mixture When the heading of the drift reached sound rock beyond the water-bearing zone, the bulkhead in the "barrel drift" was demolished and drilling of the enlarged tunnel face was carried forward in the normal manner. Later, the main bulkhead, the "barrel drift," and the massive emergency bulkhead were cleared away, and the 24-foot tunnel section was excavated for 750 feet. That was done so that the ultimate diameter of 13.5 feet of the aqueduct could be successively lined with concrete, and reinforced outwardly with supplementing walls of steel plating and other steel and concrete

But for the successful use of the "barrel drift" and the method used in sealing the bad ground which carried water at high pressure, the year of delay in advancing the heading south from Shaft 2 might have been a much longer one. The chief engineer for the contractor has stated that without using the means employed to shut out the water, the leakage might have reached the staggering total of 50,000 gallons a minute! The contractor was allowed four years in which to make the tunnel excavation, and yet, in spite of all the trouble encountered in battling with marsh gas and high-pressure water, the 75,000-foot tunnel section was holed through in a trifle more than two years.

OUR *Point* OF VIEW

PLANNING FOR PEACE IS PROGRESS

Much as normal man dislikes war, much as he yearns for peace and for the benefits that derive from peaceful pursuits, much as he protests against the wastefulness of war, he must grudgingly admit that many of the developments which are making war more and more horrible will ultimately make the peace more and more desirable. This, bear in mind, is no brief for war. Rather, indeed, it is an acceptance of the present war as a job to be done with at least a thought for the future.

In our issue of October was presented the first part of a two-instalment article surveying the effects of present operations in industry as they will be reflected in the peaceful world of day after tomorrow. Part two will be found on page 203 of this number. The thoughts presented in these two articles are, we feel, as completely divorced from wishful thinking as is possible under the stress of wartime production. They reflect vividly the determination of American industry as a whole to learn its lessons, no matter how distasteful these lessons may be, and to emerge from the present conflict with a completely new set of data on which to base a better world.

There can be no question but that the end of the war will find great changes in all industrial endeavors, that these changes will involve far-reaching dislocations on every industrial front, that these changes will in many cases be disastrous. Just how disastrous, of course, will depend largely upon how industry accepts its own responsibilities, how it plans today for the future.

It was with this last-mentioned thought in mind that the above described industrial survey was made. Every industry, large and small, simple and complicated, must realize now that not only its own future, but the future of the world as a whole depends upon this kind of planning. Such a realization will behoove every responsible man in industry to subject himself and his work to a critical analysis.

How is *your* industry planning now for the days of peace? How will *your* industry stand in the world of tomorrow when a new concept of living is rising from the knowledge gained through the war effort? What can *you* do now to aid in insuring industrial prosperity with a minimum of dislocations after the war?

A searching self-analysis on this basis can be stimulating and truly helpful. Others are doing it, as our survey results show. Everyone in industry should do it for the greatest good to the greatest number.—*A.P.P.*

IN APPRECIATION OF DOCTORS

You have worked too incessantly for too many years and are tired out, and you finally have to go to a doctor. He tells you what you probably pretty well knew already—that you must slow down or go down.

Let's assume that you follow this doctor's advice—but do doctors follow their own advice? Not too often. They keep on working till they drop. Is the tradition that doctors die too young from overwork true, or only a manner of speaking?

A Brooklyn doctor has found an interesting way to get the answer, which is: the more successful the doctor, the sooner he dies. Each week in *The Journal of the American Medical Association* there is a long series of obituary notices of deceased doctors. Each notice lists the dead doctor's life attainments. Naturally, some of these notices are long, some of medium length, others short, and it happens that, for reasons of appearance, the printer arranges the notices in order of length—longer ones preceding shorter ones. It occurred to the Brooklyn doctor that this weekly list, thus arranged, might provide an opportunity to determine "what price success" in medicine. So he analyzed 30 such weekly lists and found that the average age of death of the first ten doctors on them was 64.6 years, while the last ten doctors—they who had served faithfully but not gained prominence—lived on to 69.3 years. Thus the price of success proves to be about five years of a doctor's life.

The chances are that, if you are "successful" enough in your own vocation to be tired out from incessant work and forced to hunt up a doctor to tell you to ease up and go fishing, you will also be in a position to hunt up one of the more "successful" doctors. He, of course, will simply fortify your existing suspicions with enough added resolve to make them stick, and you then will take the needed rest, while he will go on working—and dying.

Now he's a doctor and he ought to know better and he does. But he also is human, and it's human to give advice that we don't ourselve take—most of us are a little that way.

But that's not the main reason for the tired doctor's keeping on and on. He doesn't find it simple to cut suddenly loose from his practice Too many people have come to depend on him, or think they do. He can't simply fold up and walk out—or, if he can technically, he doesn't feel he can morally. All through his working life he has had to become accustomed to the fact—and it is a fact—that a doctor ***doesn't really own himself;*** he's a kind of public institution, or public utility. So in his subconscious if not in his conscious mind he knows he's digging his own grave. yet he's a kind of soldier—he's in it and will go through with it.

And for all of this, much of which it is feared the rest of us take for granted—if we even stop to think of it at all—the doctor richly deserves our appreciation. Five years is a high price.—*A.G.I.*

THE STRANGE CASE OF SYNTHETIC RUBBER

Interesting is the report of the Baruch committee on the rubber situation. Especially so is that part which criticizes governmental agencies for the handling of the rubber program and which refers to errors "growing out of procrastinations, indecisions, conflict of authority, clashes of personalities, lack of understanding, delays, and original non-use of known alcohol processes." Strange indeed is any failure to take advantage of knowledge that is already part of the record.

Science can point the way toward new processes and industry can put them into use, yet all efforts can be in vain in a national emergency if those in high governmental positions refuse to recognize their duties.—*O.D.M.*

Miracle Beans

Long called "The Cow of China," the Soybean is Now Invading Almost Every Field of Endeavor

America in general has just begun to "discover" the widely varied possibilities of the soybean. Henry Ford makes steering wheels of it, midwestern farmers look on it as a promising money crop, diet and health practitioners are starry-eyed about its protein, calcium, and iron content, but these things are only a start. Dig deeper into the subject and you'll find that the little bean is a capital meat substitute; that coffee, cheese, candy, salad oil, lubricating oil, printer's ink and celluloid and glue, airplane bodies and rubber substitutes, are made from it. It's good for cattle—good for dog food and linoleum and paint and rayon panties, good for explosives, good for building bone and muscle in fighting men. It's a fine forage crop, and, like alfalfa, it will enrich the soil.

But five years from now, when the present war has made the soybean as familiar an institution in American life as cellophane and synthetic rubber, it will be well to remember that the "discovery" of today was known to the Chinese thousands of years before the birth of Christ. The emperor Shen Nung speaks of it in his "Materia Medica," written in 2838 B.C. Whole ages before this—before man had learned to scribble on stone walls or papyrus—a legend was current which has been handed down in northern China and Manchuria to the present day, telling how man first became acquainted with the soybean.

A caravan of merchants, says the legend, was homeward-bound, loaded with gold after a successful trading expedition, when it was attacked by bandits. Taking shelter in an easily defended ravine, the traders held off the attackers for several days until their food ran low. Starvation threatened—until one of the servants returned to camp with a sack of beans he had found on a vine-like plant which the animals were eating. They mashed up these beans to a paste with a little water and baked them—and on this crude biscuit the famished men regained enough strength to hold off the attackers until help arrived.

Soybeans on the Ford Farms

The Chinese have looked on the soybean as their staff of life for ages. Many of them have never tasted any milk but that of the soybean, which costs a quarter as much as cow's milk but contains food values that are amazing. Long has it been called the Cow of China. The Orient uses the bean not so much as a vegetable as for making cheese, sauce, bread, and meat substitutes. For thousands of years it has been the basic protein food in Manchuria, China, Korea, Japan, and the Malay Peninsula.

Soybeans first came to America in 1804 on a clipper ship whose Yankee master had ordered several bags tossed into the hold in case his provisions ran low. Admiral Perry brought home two different varieties from Japan in 1854—but until the Department of Agriculture began a systematic study of the soybean shortly before 1900, it was regarded merely as a botanical curiosity in this country. William J. Morse, now senior agronomist of the department, is the man who has worked for 34 years with the quiet fervor of a missionary to bring the miracle bean prominently into the agriculture of this country.

His efforts are now bearing fruit. In 1929 we grew nine million bushels. In 1939 we grew 91 million bushels. It's our fourth ranking cash grain crop; we grow as much as Manchuria. The Cow of China has become a hundred-million-dollar American industry.

Why? Because the little bean really is remarkable. It actually does all those different things you hear about. The plant itself makes excellent fodder for animals, or a wonderful soil-enriching crop, and it brings nitrogen to the soil. It gained its first real impetus in Illinois, now America's biggest soybean region, when farmers planted it to revitalize the land after the reckless forced growth of corn there during the last war. But it is the bean itself, the actual fruit of the plant, which has turned out to be the treasure chest from which today's scientists are extracting food and industrial products.

The secret of the soybean's versatility lies in its chemical composition: 40 percent of it is protein, highly digestible, and another 20 percent is fat, which can be squeezed out or chemically extracted as oil.

More than three fourths of the oil now goes into food products, with the bulk of the rest going into paint, lacquers, and soaps. What's left after the oil has been extracted makes soybean meal, almost all of which is used at the moment in feed for livestock. Out of the 5 percent that does not go into animal feed we get plastics, flour for baking, glue, fertilizer, dog food, breakfast cereals, macaroni, baby foods, reducing diets, and diabetic foods—for which soybeans are admirably suited, having a very low starch content.

Soybean oil is now an economic rival of cottonseed oil and peanut oil in the commercial vegetable oil market. It has one great advantage here. Grown on mechanized farms with little human labor, the soybean crop can expand as rapidly as the industrial market demands. Soya oil, like many

Courtesy "Ethyl News"

petroleum products, is refined and hydrogenated; refining makes it sparkling clear and almost tasteless, while hydrogenation stiffens it to the consistency of cooking shortening—into which many tank carloads of it now go.

It has an overwhelming advantage as a protein food also. Usual sources of protein are meat, fish, milk, and eggs — all of which need refrigeration. But soybean meal contains a great amount of protein—and it can be shipped dry, with no cooling. This fact, plus its high nutritive value, are two reasons why the Army is using it in its new super-pemmican, Pararation. Although our national demand for soybeans in recent years has run only about 25 million pounds a year, in 1941, Lease-Lend to Britain took 40 million pounds.

Soybean fiber, being carded here, has possibilities as wool replacement

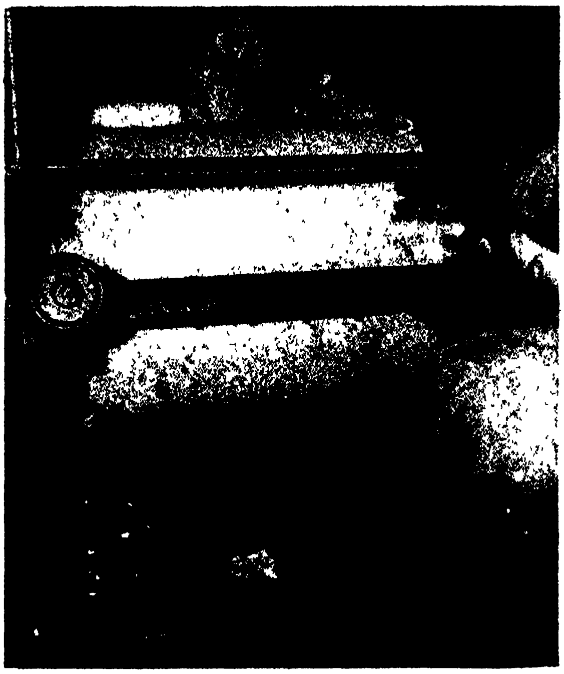
Soybean fiber, loose skeins, bobbins of yarn, on cloth made from the fiber

One proof of the value of soybeans in a wartime economy is the importance the Germans attach to them. When Hitler and Stalin were still "friends," Germany siphoned a steady stream of beans from the Orient across the trans-Siberian railway; there were all sorts of disappointing delays, but enough beans got through to give the Germans a four-year supply. The Russians also were growing a fine crop of beans for Hitler but somehow the harvest went into Russian bins instead of railroad cars headed for the German border. This was just as well for the Allies, because the two dictators had a misunderstanding shortly afterwards and Hitler put his chemists to work on the task of making a super-explosive out of soya oil.

To show how versatile a vegetable is the soybean, look at a list of the other things Hitler could make from soya oil besides explosives. He could produce (and we're doing all this in the United States today) glycerine, printer's ink, waterproofing for umbrellas and other fabrics, leather dressing, paper coating and sizing, lubricating oil, lighting oil, enamels, varnishes, paints, soap, rubber substitutes, and lecithin. What is lecithin good for? It makes an excellent coating for chocolate confections — keeps them fresh and adds a certain nutlike flavor. It's used in the manufacture of linoleum for your kitchen floor, and rayon for eking out the country's supply of silk. And it's used a good deal as an anti-sludge stabilizer in gasoline.

MOST of us recall a newspaper picture some time back of Henry Ford whanging an axe into the rear of one of his cars. He was demonstrating, dramatically, the toughness of a trunk door made of soya plastics as compared with a similar door made of standard sheet metal, in which a similar axe-blow left a gaping wound. Such pictures and stories have helped greatly toward making the public realize how much pioneer work Ford has done in finding industrial uses for the soybean and other products of the farm. In the past few months alone his laboratories have developed from soybeans water paints which stand up under a lot of abuse from the weather, and which photograph poorly from the air. They are thus excellent for camouflaging buildings, an important phase of defending our industries from attack—and have the further advantage of being easily washed off after the need for camouflage has passed, provided they are applied over the proper preparatory base. Soybean meal, made into a protein solution, can be coagulated into thread for fiber; this fiber has possibilities of replacing wool, which is now on the priorities list. It resembles wool in its general characteristics, has a natural crimp, and is about 80 percent as strong, with good possibilities that the strength will be increased. Ford fiber has been used by commercial mills to augment the supply of wool; apparently it will eventually make satisfactory felt blankets, hats, sweaters, and suits. Henry Ford has a suit made of 25 percent soybean fiber. His Highland Park mills, set up originally as a pilot plant, produced 1000 pounds of fiber a day at half the cost of sheep's wool before they were moved to Dearborn to go into increased production. Robert Boyer, his brilliant young soya reasearch chief, points out that two acres of land used as grazing pasture for sheep will produce eight to ten pounds of wool a year. Two acres planted in soybeans will produce 400 pounds of protein suitable for fiber.

Boyer's most interesting contribution, however, has not been soybean cloth or even the plastic dashboards and in-



Preparing a soybean plastic molding compound

strument knobs he casts in such bright colors. He has devised tough, lightweight, fiber-and-plastic sheets suitable for molding into automobile, jeep, or airplane bodies—tough enough to resist even an axe, as Henry Ford demonstrated for the newspaper photographers.

In these structural sheets, soybean meal furnishes the bonding resin rather than the actual fiber. (Experiments with soya fiber show that it produces very hard but very brittle sheets.) Long and short fibers of hemp, flax, and ramie are mixed and floated in water into a mat which is roughly the shape of the mold to be used. This mat is dried and impregnated with the soybean resin binder, then placed in a mold where heat and pressure shape it to the proper form—tough, polished as smooth as the mould itself, already colored without painting, and practically impervious to heat or moisture.

Since this molding process took six times as long as stamping out steel sheets for bodies, Boyer developed a method of stacking six molds simultaneously in the same press, so the output was the same. And since the plastic sheets had only half the tensile or "tearing" strength of steel, they were made doubly thick—and turned out to have collision-proof qualities ten times superior to those of steel. No jagged edges, no permanent dents. The post-war automobile body, as Ford envisions it, will be made of these plastic forms bolted in place to a tubular steel framework which will replace the conventional chassis. The body will weigh only half as much and the car as a whole will weigh only 85 percent as much as the 1942 models did.

One company is now making military airplanes with molded bodies in which soybean resin is used as the waterproof binder. Controls and ignition parts on many planes are cast of soya plastics—and the sand cores used for castings, both metal and plastic, in many defense plants are held together with a soya binder. This war has truly been an incubator for the soybean, giving it new life in a hundred new uses which would have been beyond the conception of those beseiged merchants who, in desperation, first ate the bean to stave off starvation so many centuries ago.

But let us not lose our perspective, and succumb to the popular misconception of soybeans as being primarily grown for industrial uses or for sauce in Chinese restaurants. Only 5 percent of the soybean meal produced and only 15 percent of the oil extracted go into industrial use. Soybeans are still primarily a food crop, for animals and for us. If we have to feed half another continent after this war, we could not ship any other food as nutritious, as full of minerals and vitamins, as rich in protein, as versatile in such a variety of dishes and forms, as the soybean—and this is worth noting, since we may find ourselves the Granary of Democracy after we get through being its Arsenal.

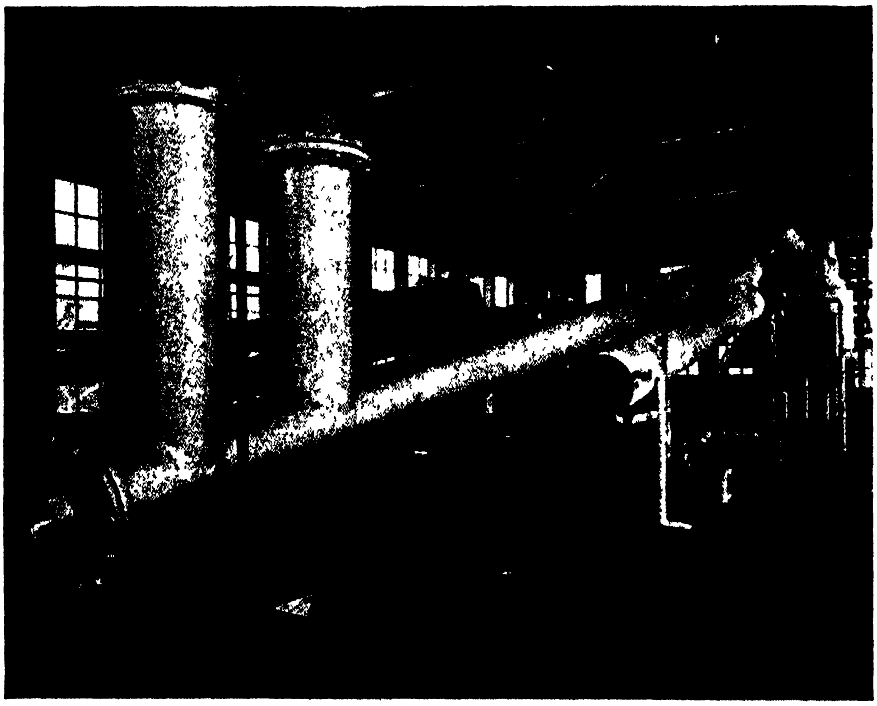
• • •

PARTIAL PREFABRICATION

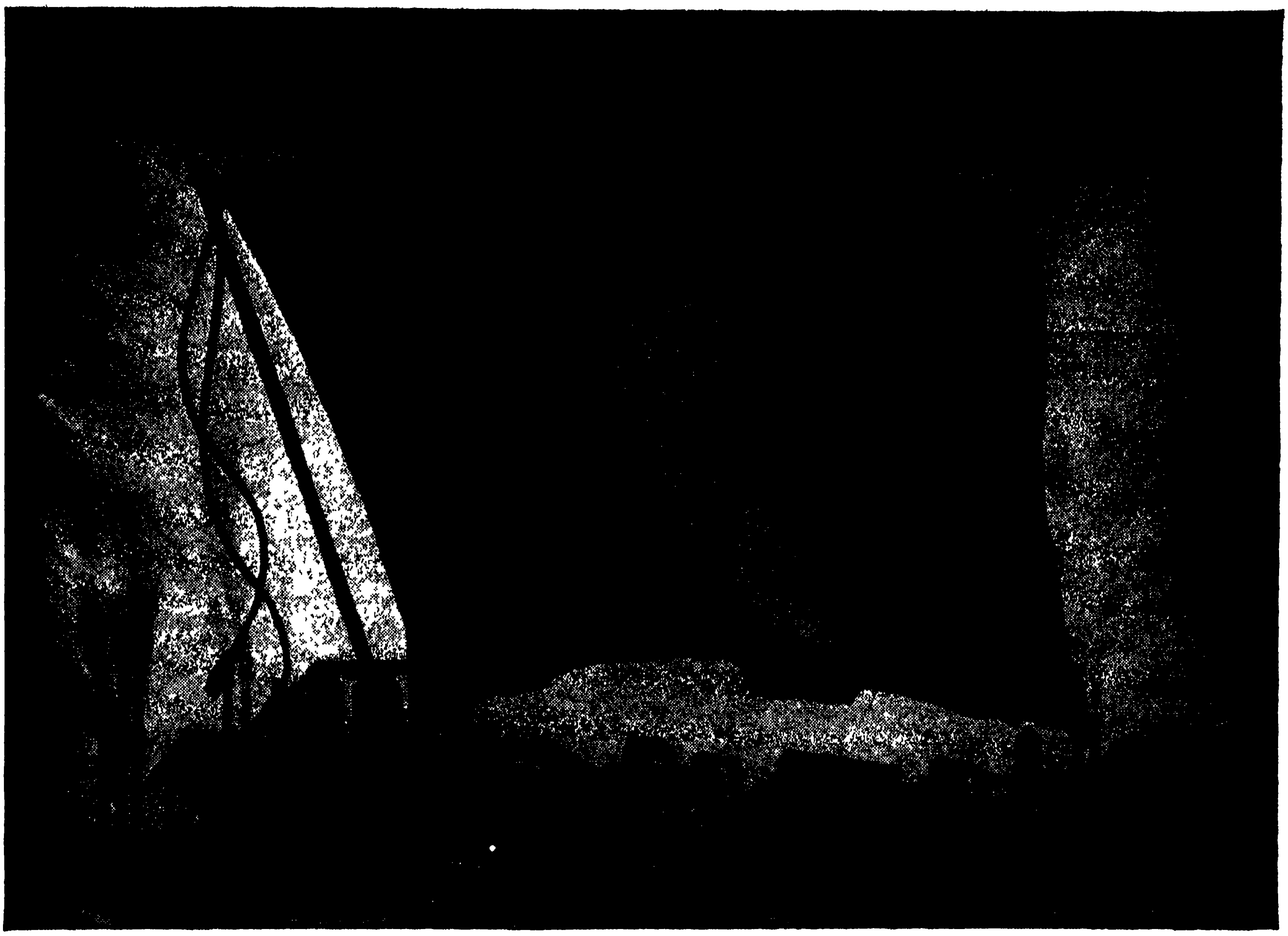
Modern Phase in Building Construction has Advantages

WHEREAS the prefabricator of six years ago constructed the "packaged" house in its entirety and shipped it to buyers throughout the country, ready to be assembled on the site in a few hours, the mushrooming of the prefabrication industry in the last six months, due to necessity for immediate large-scale housing units, has introduced a new factor into house construction. This is the advent of a middleman into the prefabricating field—the partial prefabricator—who justifies his existence by supplying "parts" or sub-assemblies to the actual "prefabricating contractor" at the job.

After a trial-and-error period, a number of prefabricators found the "packaged" house construction impractical except in the immediate vicinity of the mill. Now, however, a number of companies that have gone into the partial-prefabrication field are producing portions of houses for which their plants are most fitted—wall sections, windows, doors, steps, and so on. These parts are then supplied to the actual prefabricating firm on the job



Equipment used by Ford for extraction of oil from soybeans



Next to the Stars and Stripes . . .

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Signifying 90 Percent or More Employee Participation in the Pay-Roll Savings Plan

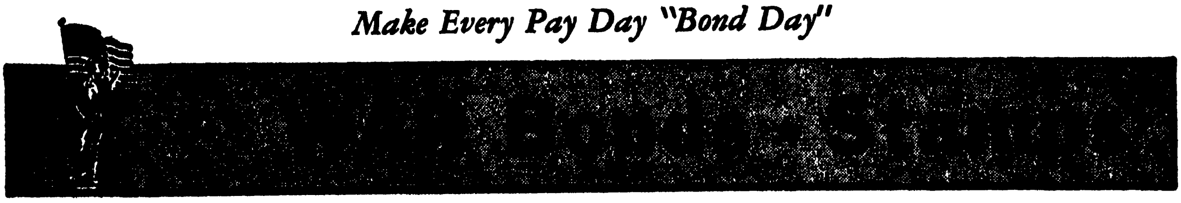
IT doesn't go into the smoke of battle, but wherever you see this flag you know that it spells Victory for our boys on the fighting fronts. To everyone, it means that the firm which flies it has attained 90 percent or more employee participation in the Pay-Roll Savings Plan . . . that their employees are turning a part of their earnings into tanks and planes and guns *regularly*, every pay day, through the systematic purchase of U. S. War Bonds.

You don't need to be engaged in war production activity to fly this flag. Any patriotic firm can qualify and make a vital contribution to Victory by making the Pay-Roll Savings Plan available to its employees, and by securing 90 percent or more employee participation. Then notify your State Defense Savings Staff Administrator that you have reached the goal. He will tell you how you may obtain your flag.

If your firm has already installed the Pay-Roll Savings Plan, now is the time to increase your efforts: (1) To secure wider participation and reach the 90-percent goal; (2) to encourage employees to increase their allotments until 10 percent or more of your gross pay roll is subscribed for Bonds. "Token" allotments will not win this war any more than "token" resistance will keep our enemies from our shores, our homes. If your firm has yet to install the Plan, remember, TIME IS SHORT.

Write or wire for full facts and literature on installing your Pay-Roll Savings Plan now. Address Treasury Department, Section D, 709 12th St., NW., Washington, D. C.

Make Every Pay Day "Bond Day"



This Space is a Contribution to Victory by SCIENTIFIC AMERICAN

though it may be thousands of miles distant.

An example of this is the Speedwall Company, a division of I. F. Laucks, Inc., which started as prefabricators in 1936, and have built hundreds of prefabricated houses for various government and private agencies throughout the country.

The Speedwall Company is using its machinery almost entirely now for partial prefabrication. One of its principal products is giant plywood board for both exterior and interior use. A feature of the Speedwall board is that its construction is such that it is applied cross-grained to the studding. This gives a wall construction more than four times as rigid as when the plywood is applied with face grain parallel to the studding. The giant board is eight feet wide, and is run off in a continuous line like newsprint paper. Thus it can be cut to any length as required by the prefabricator.

Another partial-prefabrication is the construction of double-wall sections—containing both the interior and exterior walls of a house. The company has found that they can glue up double wall sections at the rate of 310 lineal feet of 8-foot-high partitions per hour, or 2480 lineal feet per 8-hour shift. This is enough double wall sections for 20 complete average 5-room houses per day.

The prefabricator, now that a great deal of his work has been taken over by partial-prefabricators, has become, in many cases, virtually a local distributor or assemblyman—often a general contractor, or an alert dealer. He purchases prefabricated portions of homes from various partial-prefabricators throughout the country, assembles them for occupancy on the home grounds, speeding the job and bringing all of the building industry's factors into the prefabricating picture.

PIPE FINDER

Makes It Possible to Avoid "Striking Oil"

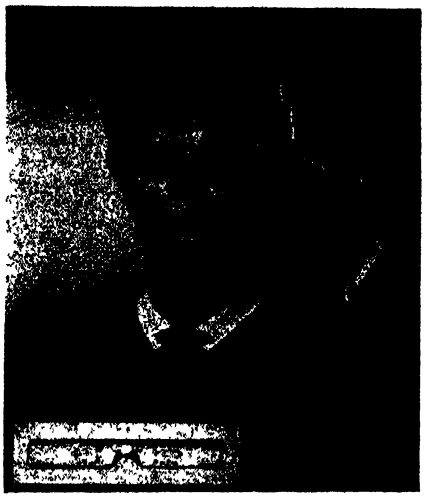
There have been many sorts of divining rods for locating buried treasure, ranging from the forked hazel twig of the "water-witch" to the modern electrical detectors for locating buried cable or pipe. Perhaps the "last word" among the lot is the type developed by the Bell Telephone Laboratories, which is so accurate that it can determine within less than an inch, both laterally and in depth, the position of a telephone cable buried three feet or more underground.

This detector is also useful in locating pipes and other metal obstructions beneath the surface, as, for example, where a new cross-country cable is being plowed underground. On one 83-mile run recently in constructing a major telephone route, there were 91 crossings of oil pipe lines. By determining these locations, telephone engineers were able to avoid "striking oil" the wrong way, and also saved valuable time.

DISPENSOMETER

Aids in Accurate Fitting of Eye-Glasses

A new optical dispensometer molded of crystal clear "Lucite" methyl methacrylate resin combines in one instrument everything required to obtain measurements for accurately fitting glasses to a patient's face.



"Has everything" for eye-glass fitting

The transparent plastic instrument magnifies the pupil of the eye almost three times for vertical measurements, affording greater accuracy and easier visibility to the optician.

Fitting snugly over the bridge of the nose and containing all the necessary rules and scales, it is light in weight, virtually unbreakable, and can be sterilized in any of the usual cold antiseptics.

• • •

KEROSENE—Even in this age of progress in electricity, there are still more than 2,000,000 dwelling units along the Atlantic seaboard which use kerosene or gasoline for household lighting.

• • •

SHELTERBELT TREES

Set New Survival Record

Trees planted in the shelterbelts of the Prairie States Forestry Project last year made the highest survival record since the project, now completing its seventh year, was started. According to the United States Department of Agriculture's Forest Service, the survival shown by sample counts taken in the six prairie states was 82 percent compared to 79 percent in 1940, the highest previous record, and the low of 52 percent in 1936, the worst drouth year.

Last year's planting of 2702 miles of shelterbelts on 4696 farms brought the total to 16,104 miles on 26,375 farms. The field windbreaks, many of them more than 35 feet high, will provide the basis for protection of crops and soils on approximately 3 million acres of land or an area almost equal to the size of Connecticut. This protection, afforded where trees are already high enough, will aid in meeting food production goals.

Many of the belts planted six or seven years ago, the Forest Service reports, are already yielding fence posts and some fuel for their farm owners as a result of thinnings being made under the general supervision of foresters charged with responsibility for the project.

CONCRETE SEALING

Liquid Material Retains Water for Curing

A clear liquid that is sprayed on wet concrete after finishing or on formed concrete after the form has been removed, seals the surface to retain water and thus facilitates curing. This liquid, known as Tru-Cure, does not affect the color of the concrete yet gives moisture retention of about 96 percent after 24 hours at 110 degrees, Fahrenheit, and 90 percent after seven days.

CONTAINERS

Use Cellophane to Replace Metals

A thin transparent film of cellophane—a thousandth of an inch "thin," to be exact—is tackling the job of replacing thousands of tons of steel, tin, and rubber in the packaging of foods and other essential items for America and her allies.

One of the most important of the new cellophane applications is in the fiber "can," where it adds its protective values and strength when laminated to cardboard. Some of these "cans" resemble the familiar cylindrical ice cream container; in others the metal can body is replaced by laminated board and cellophane, with the metal ends attached in the usual way, saving 60 to 80 percent of the metal. Already hundreds of thousands of this type of package have been used to pack lard and baking powder. Experiments have shown that many other products now packaged in metal containers, such as syrups and greases, powdered foods, coffee, and various oils, may also be packaged in this manner. Even concentrated fruit juices have kept fresh for months in such cardboard, cellophane-lined packages.

Another widely used form of package might be termed the bag-and-box; a leak-proof cellophane bag is formed inside a carton—or fabricated as an integral part of a carton—and tightly sealed merely by heat. Vegetable shortening and quick-frozen foods are among the foods packaged in this manner.

Curiously enough, when cellophane is added to paperboard, as in the cardboard "can" or the bag-and-box package, its use is exactly similar, both in principle and actual weight, to tin added to steel in the form of tin plate. So cellophane is replacing tin pound for pound and is enabling cardboard to replace steel many times its own weight.

Still another saving achieved by cellophane is in its conservation of metal through substitution for foil which has been used in great quantities in wrapping processed cheese. Until fairly recently the 325,000,000 pounds of processed cheese produced annually in this country used 4,600,000 pounds of foil. Air-tight, moisture-proof film does this job effectively, preventing the cheese from becoming rancid and moldy and dry.

VITAL MATERIALS

Formerly Imported, Now Produced at Home

A BRIDGE of ships spanning the Atlantic, spaced only a trifle over one mile apart, would be required to bring to America just five of the many vital war products which the chemical industry has developed synthetically since 1917.

That is the direct contribution which research laboratories and chemical developments have made in the last 25 years to alleviate the acute shipping shortage of today.

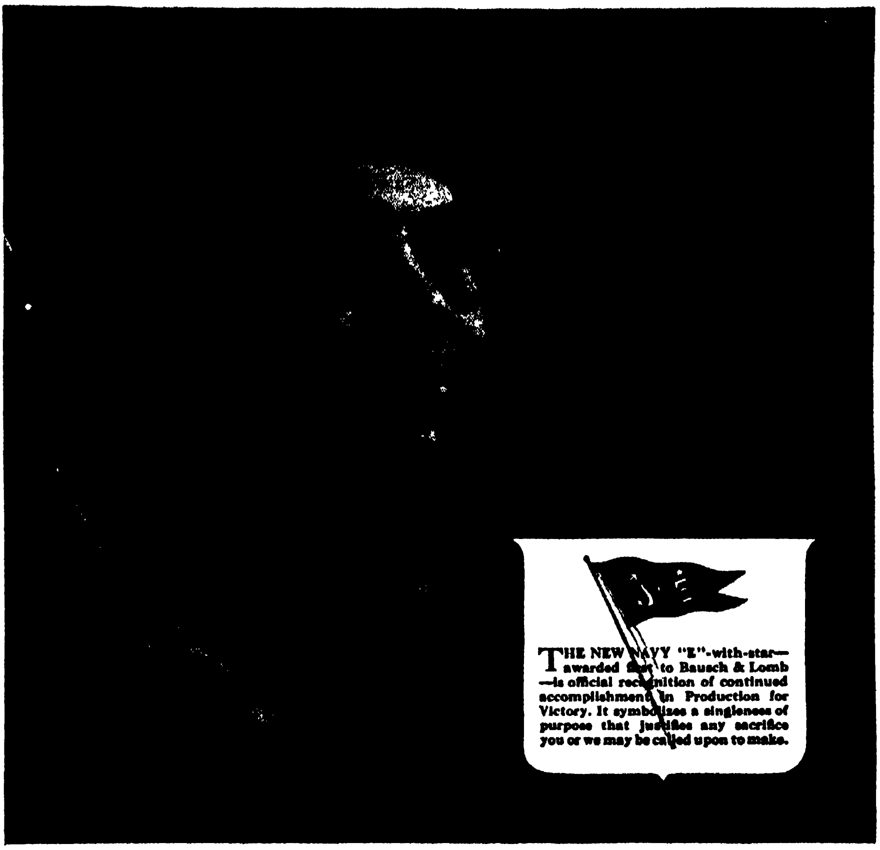
The five products are nitrates for explosives production and other uses; rubber for a mechanized army and necessary civilian transportation; dyestuffs for uniforms, various types of military equipment, and civilian clothing; fibers for parachutes, powder bags, and essential industrial uses; and camphor, used medicinally and in the manufacture of many chemical products essential to the war.

To bring these things to America in the quantities either required this year, or, where such figures are unavailable, actually imported before the chemical equivalent was in production, would require 2682 sizeable cargo ships. The distance from New York Harbor to Queenstown is 2842 miles. These ships spread over that distance from the Battery to Ireland would be just over one mile apart.

Of the products, the only one that would actually be obtainable, no matter how many ships were available, would be nitrates, with Chile the main known commercial source of natural supply. Before being made in America by the chemical industry to meet peacetime needs and now translated to vital wartime necessities, all the other products came from what are now enemy sources.

Not only is there no necessity now for protecting the 2682 ships on a voyage from Ireland to New York or its equivalent, but these ships are vessels which in all likelihood will never need to sail again. For when this war is over, the greater part of American needs for rubber may well be supplied by the man-made chemical equivalent.

A few years ago the only source of camphor was the natural product from Formosa. Du Pont now makes


THE NEW NAVY "E"-with-star—awarded first to Bausch & Lomb—is official recognition of continued accomplishment in Production for Victory. It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make.

American War Birds Have Keen Eyes

FOR America's fighting forces, strictest requirements are imposed on the men who fly the fighter planes. Stamina, keen perception and split-second timing depend on condition. In the most critical physical examinations, particular emphasis is given to perfection of vision.

Several years ago, at the request of U. S. Army officials, Bausch & Lomb developed a special anti-glare glass for use in bright overcloud flying. This glass, known as Ray-Ban, has the remarkable property of filtering out excess glare-producing light, at the same time transmitting most of the light useful for seeing. Army, Navy and airline pilots—as well as target shooters and motorists—have welcomed the cool, comfortable, keen vision that Ray-Ban affords.

So, again, and in still another way, Bausch & Lomb gives aid to America's all-out for Victory. Its other contributions, more obvious, include gunfire control equipment—range finders, binoculars, aerial height finders. Behind the scenes, but of no less importance, are the instruments of industrial research and production—metallographic equipment, spectrographs, toolmakers' microscopes, contour-measuring projectors. Bausch & Lomb eyewear products—eye examination instruments, spectacle lenses and frames—keep a nation of workers at top visual efficiency.

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Cells are in excellent condition. Complete with solution, connections and trays. Prices below are about 10% of regular market price. Average life 20 years. Two-year unconditional Guarantee.

A-4	Amp. Hrs. 150	Ea.	$6.00
A-6	Amp. Hrs. 225	Ea.	6.00
A-7	Amp. Hrs. 262	Ea.	7.00
A-8	Amp. Hrs. 300	Ea.	7.00
B-2(J-3)	Amp. Hrs. 37	Ea.	5.50
M-8	Amp. Hrs. 11	Ea.	2.00
L-20	Amp. Hrs. 13	Ea.	2.50
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All cells 1.2 volts each

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less an additional charge of 10% is to be added for trays.

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Signal Corps telegraph key and sounder mounted on mahogany board. Operates on 2 dry cells.................. $5.95

GLASS MERCURY TUBE SWITCHES

3 amp. .... $1.25 10 amp. $2.25
6 amp. .... 1.95 20 amp. 2.95

Lighting Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.

Price $225.00

Additional data on request.

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U. S. Army Engineers, Geologists, Surveying, Mapping, etc. Magnifying Eyepiece. $3.50

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Six number, (999999) non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special... $7.50

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operating volts 12,500, cap. 004.
Dubilier, new $12.50
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Condenser, Dubilier, mica, op. volts 8,500. cap. 004 ....$7.50

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SIZES FROM #39 to .001

U. S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts. $2.95

Single Stroke Electric Gongs

Edwards 12" bronze DC 5 Ohm Mech. Wound $18.00
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Engineers U. S. Army Precision Type Tripods

Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ⅝" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips Weight 5 lb.
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Dia.	Focal Length	Glass Thickness	Price
11 in.	4 in.	⅜ in.	$15.
20 in.	12½ in.	7/16 in.	75.
26 in.	18¼ in.	7/16 in.	125.

Made by Bausch & Lomb & Parsons. Perfectly ground and highly polished.

A few 60 in. slightly used metal mirrors on hand $225. ea.

U. S. Navy Divers Lantern

Electric 150 watt, any voltage, solid cast brass. 300 lb. test. Weight 12 lb.
Price $8.50

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric, Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate. Exceptional value $2.95

U. S. Army Engineers Prismatic Compass

Pocket type 360° Limited quantity. $10.50

HUTCHINSON PRISMATIC COMPASS

3 in. dia., brass, black enameled, improved pattern, with opening in top, floating jeweled dial. 2 in. Each... $16.50

DYNAMOTORS D. C. to D. C.

24-750 volt. Gen. Electric 200 mills $27.50
24-1000 Gen. Elec. 1000 mills $50.00
12-350 volt 80 mills $18.00
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Prisms, Binoculars, Bausch & Lomb, used, slightly chipped, 1 11/16 inch long by ⅝ inch wide $2.00

Bunnell Resistance Box 1 to 10,000 ohms. A beautiful piece of laboratory or test apparatus, Complete with plugs. $30.00

New .6 H.P. 2-phase 60 cy. 220 v. 3450 r.p.m. Westinghouse. $35.00

New 1¼ H.P. 1-phase 60 cy. 110 or 220 v. 3450 r p m Diehl, Ball Bearing. $55.00

Motor generator, R & M 110 D. C. 3½ H.P., 2 kw. 20 volt 80 amp. $120.00

MOTOR GENERATORS

120 d c., 110 or 220 a.c., 500 cycles, 250 watt. $125.00 to $175.00
120 d.c., 110 or 220 a.c., 500 cycle, 500 watt. $175.00 to $250.00
120 d.c., 110 or 220 a.c., 500 cycle, 1 kw. $275.00 to $325.00
120 d.c., 110 or 220 a.c., 500 cycle, 2 kw. $300.00 to $425.00
120 d.c., 110 or 220 a.c., 500 cycle, 5 kw. $425.00 to $550.00
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"Wappler X-Ray Co." 110 or 220 d.c. input—75 or 150 a c. output.

½ KVA .... $45.00 3 KVA $95.00
1 KVA .... $65.00 5 KVA $110.00
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Radio Transmitting Key, large Navy 5 K W., back connected, splendid action, ⅝" heavy silver contacts. $10.50

U. S. Navy rotary spark gap, enclosed multiple electrode, high speed, can handle 10 kilowatt. ¼ H.P., 110 v. vertical motor (specify AC or DC). $75.00

Telegraph and buzzer portable sets, mahogany case, 2 tone 4 contact platinum point high frequency buzzer, 2 telephone toggle switches, potentiometer, sending key, 3 mfd. condensers, transformer and 2 choke coils, receiver. ...$10.00

Webster ¾" spark coil, 110 volt, 60 cycle 30 watts, with vibrator $5.00

Motors, Synchronous, 220 v. 60 cycles 1800 R P.M. ⅛H.P. $30.00

Motors, Synchronous, 220 v. 60 cycles 1800 R.P.M. ½H.P. $60.00

U. S. N. double current generator, 450 volt at 250 mills and 9 volts at 3.75 amp. Complete with filter. May be used as dynamotor .. $55.00

MANHATTAN ELECTRICAL BARGAIN HOUSE, INC., Dept. S.S., 120 Chambers St., New York City

all the camphor it is called upon to provide from Southern pine and at a fraction of the cost.

Importations of crude rubber in 1940 amounted to 814,604 long tons, according to figures of the United States Department of Commerce. It would take 270 medium sized ships to carry a cargo of that amount from the East Indies to the United States. Because of the great distance this is the equivalent in ton-miles of at least twice as many ships, or 540, making the run from Europe to the United States.

To bring from Chile the nitrogen needed to sustain the rate of explosive and fertilizer production, and other necessary chemical uses, during the second half of the calendar year 1942, would take 300 sizeable ships making seven round trips a year.

Since dyestuffs, silk and camphor are relatively concentrated products, comparatively little shipping space is required for them. Yet in 1940, a year of very restricted buying of silk, Department of Commerce figures show 44,857,055 pounds were imported. During 1913, the last year of unrestricted purchasing of dyestuffs from Germany, 42,840 tons of dyes were imported, chiefly from Germany. During 1917, before the development of synthetic camphor, 8,621,000 pounds were imported.

The shipping requirements for these products would be 42 ships making a 2800 mile run—equivalent to the Atlantic crossing—yet the requirements of the American industrial machine now for the equivalent of these products are larger than in the years during which the Commerce Department figures were taken.

Thus the long arm of chemical research reaches out, not only to make the American industrial war effort easier, but to relieve the most acute of all present problems—shipping—and to give the United Nations the vital materials required to win the war.

MORE BUTTER

Assured by Protecting It from Mold

More than 75,000,000 pounds of butter will be wrapped in specially impregnated parchment paper during the current year to protect it from losses due to mold, reports the Du Pont Food Research Laboratory. Great quantities of butter are expected to be saved from spoilage as a result, thus helping to conserve stocks.

Mold rarely can be recognized in butter except by an "off" taste, according to food experts. Its growth can be retarded, even in warm weather, however, by wrapping the butter in paper treated with a mold inhibitor. The baking industry also is attacking the mold problem in baked goods by incorporating mold retardants in increasing quantities of bread, pies, and cakes.

• • •

FISH PONDS—Fertilization of fish ponds results in increased growth of small plant life. This in turn makes possible a greater production of fish, in a ratio of about 500 pounds of fish per acre from a properly fertilized pond to 100 pounds for the average unfertilized pond.

• • •

CIRCUIT BREAKER

Designed to Foil Sabotage of Power Lines

Power-snuffer guards against sabotage

DEVELOPMENT for war factory power systems of a new noise-proof "safety valve," called a limiter, that snuffs out 54,000-kilowatt torrents of electricity—equivalent to more than 70,000 horsepower—has made possible a new sabotage-proof method of distributing high-voltage power in factories.

"In this new system of industrial power supply, known as a secondary network, two separate circuits supply power to all parts of the factory," said Mr. J. M. Wallace, Westinghouse engineer who developed the limiter. "If one circuit is damaged, by sabotage or a short circuit, the other circuit keeps electricity flowing to machines turning out war materials.

"The limiter was needed to protect these double-circuit cables against serious damage from a short circuit, which might be caused by worn out insulation, by water seeping into a cable, or by a wrench falling across bare conductors.

"Such a short circuit melts a pencil-sized copper bar inside the limiter, disconnecting the circuit. Otherwise, the short circuit might damage the cable more seriously and spread to adjoining cables. Once blown, the inexpensive limiter can be replaced by a new one."

The average 600-volt factory power cable is expected to carry only 460 kilowatts of electricity normally. The engineer stated that the limiter is so designed that it will not go into action as soon as this normal power is exceeded, but will wait until the short circuit power builds up to many times the normal amount.

"This delayed action is desirable, because most cables can carry an added electrical load for a short time," he said. "If the limiter waits, the trouble may clear itself, avoiding power interruption for the replacement of a blown limiter. For example, if a wrench were accidentally dropped across the power lines, it might soon melt, ending the cause of the short circuit."

But if the short circuit becomes serious, the limiter goes into action, stopping the electrical flow in a sixtieth of a second, Mr. Wallace explained. It does this by heating a narrow section in the copper bar through which the electricity is flowing to more than 4,000 degrees, Fahrenheit, transforming it into a vapor. Heat of the flowing electricity also releases a blast of gas from a piece of fibrous material surrounding the bar. The gas quickly blows out the electric arc between the melted ends of the bar, extinguishing the flow of electricity.

LIFE-SAVER SUIT

Can be Worn By Sailors on Duty

A LIFE-PRESERVER suit built to cope with today's wartime sea hazards and featuring "built-in" flashlight, knife, whistle, and yellow hood and yellow-palmed gloves is another contribution to the safety of American seamen. It has special construction affording improved protection for long exposure.

HOW TO GET THE MOST OUT OF YOUR LATHES

No. 2 ***in a series of suggestions made by the South Bend Lathe Works in the interest of more efficient production.***

Keep Them Well Oiled

All bearings should be oiled at regular intervals

For lack of oil the bearing was lost;
For lack of a bearing the tank was lost;
For lack of a tank the battle was lost;
All for the lack of a film of oil

Paraphrasing the rhyme about the horseshoe nail, an army officer is said to have used this verse to emphasize the importance of lubrication. The proper lubrication of lathes and other machine tools will help our war effort by preventing production interruptions, and saving critical materials and labor by reducing the demand for replacement bearings, parts, and machines.

South Bend Lathes, like other fine machine tools, have large oil reservoirs, felt wicks, and oil retainers to guard against lack of oil due to temporary neglect or oversight. But for best results the lathes should be oiled at regular intervals. Even a camel must have an occasional drink.

Make Oiling a Habit

All oil holes and oil cups should be filled at least once a day—oftener when top speeds and feeds are employed. Best practice is to fill each oil hole in a regular sequence so that oiling becomes a habit and no oil holes are overlooked. When the lathe is in service on two or more shifts, oiling the lathe should be the first daily task of each operator.

Use Correct Grade of Oil

When the correct grade of oil is used in a well designed bearing there is little or no metal-to-metal contact. However, when the wrong grade of oil is used, or if the oiling is neglected, the oil film will break down and the bearing surface may be damaged in a short time.

Write for Bulletin No. H2

Bulletin No. H2 giving more complete information on oiling the lathe will be supplied on request. Oiling charts for South Bend Lathes (advise serial number), and reprints of this and other advertisements in this series can also be supplied.

SOUTH BEND LATHE WORKS

Dept. 511 **South Bend, Ind., U. S. A.** **Lathe Builders for 35 Years**

For Instance...

. . . during the grand wind up of the three-day battle of Midway—two American pilots in radio conversation.
Pilot Number One: "Do you see any gas coming out of my plane? There's no fuel on the gauge."
Pilot Number Two: "Yeah—you got a hole in your tank." . . .
(news item)

. . . a pursuit pilot who fought as a soldier on Bataan reports on a Jap landing party: "They have the best equipment I ever saw. Everybody had special field radios" . . . etc.
(news item)

Interesting!

Watch for radio use in the war news — you'll find it in the air — on the ground — and at home!

Without radio, the movement of war would still be anchored by telephone lines—the physical hazards of the courier and visual signals.

Now war moves swiftly over the whole face of the earth—instantaneous radio communication thru the ether instead of over copper wires has blasted the barriers of space and time.

So today all our radio production centers on war use.

But what of tomorrow—what effect will this have upon the future—after victory?

One thing is certain—it will revolutionize and speed the great new future form of transportation.

Radio has never been universally necessary in transportation before. In automobiles—on trains—it has been entertainment—in boats it has been a great aid but not an essential.

But today for the future, in that great, new universal transportation that is forming itself—the airplane—radio is essential as the engine itself.

And—mark this well—airplanes and radio are two of the four *great* industries destined to lead this country back to business normalcy after the peace is won.

Zenith's leadership in the radio industry has been established by a constant achievement of "firsts." Repeatedly, ideas "brand new" when Zenith "first" introduced them, later became essentials on all radios. And that same "forward thinking" of engineers and factory and organization now concentrates on war production of the thing we know—radio—exclusively radio. We are progressing—we learn every day—and this new experience will inevitably reflect itself when Zenith again produces for peace.

—a Zenith Radio Dealer near you is giving reliable service on all radios—regardless of make.

ZENITH RADIO CORPORATION—CHICAGO

ZENITH RADIO
RADIO PRODUCTS EXCLUSIVELY
WORLD'S LEADING MANUFACTURER

The new self-buoying garment being made by the B. F. Goodrich Company weighs a few ounces over 14 pounds and slips on over a sailor's regular clothes. In an emergency, it can be donned in a few seconds.

Weighted soles keep the wearer upright without effort, so that he floats head and shoulders above the water. A specially designed neckband prevents leaking of air or water.

Tests have shown that the suit is "manageable" enough to be worn during duty on shipboard as a shield from wind and spray. In that case, the "non-skid" material of the gloves permits handling of equipment without slippage.

Not a "Zoot suit," but the latest equipment for saving lives of seamen, this zipper-equipped cover-all is self-bouyant, quickly donned in case of emergency

• • •

WAR PROGRAM—For every hundred dollars spent in the United States War Program, \$23 goes for airplanes; \$21 goes for tanks, guns, and ammunition; \$12 goes for transport, equipage, and miscellaneous supplies; \$10 goes for naval ships; \$9 goes for industrial facilities; \$8 goes for posts, depots, and stations; \$5 goes for merchant ships; \$4 goes for stockpile and food exports; \$3 goes for pay, subsistence, and travel for the armed forces; \$1 goes for housing; \$4 goes for miscellaneous war expenditures.

• • •

ASIA'S SECRET

How Long Has Man Been in America?

Siberia holds the secret as to when the first human beings came to America, how they got here and whence they came, according to Dr. Edgar B. Howard, vice-director of the University Museum, Philadelphia.

But science cannot yet give a definite answer to the query: How old is man in America. Opinion in archeological and anthropological circles revolves around the estimate of about 10,000 years ago for the advent of man on this continent, Dr. Howard explains, but extreme estimates range from about 2000 B.C. to 70,000 years or more ago.

"Many secrets, so far as our own country is concerned, are locked up in Siberia," Dr. Howard said. "Until we know more of the glacial geology, anthropology, and archeology of this region, we cannot hope to answer, with any degree of satisfaction, questions such as that relating to migration routes, the culture stage reached by these early wanderers, and many others which are necessary as a foundation to a real understanding of American prehistory." — *Science Service.*

MINIATURE MOTOR

Runs on Dry Batteries, For Specialized Applications

An electric motor that weighs only six ounces and measures approximately one by one by two inches, has recently been designed by Delco Appliance Division of General Motors for specialized industrial and other applications in war production. These motors operate at speeds ranging from 5000 to 12,000 revolutions per minute, with outputs of from one to two watts. Operating voltages may be 6, 12, or 24 volts, supplied by dry batteries, as required.

KNIFE SHEATH

Made of Plastic, Is Light in Weight

Replacement of aluminum in non-military production is one of the side-

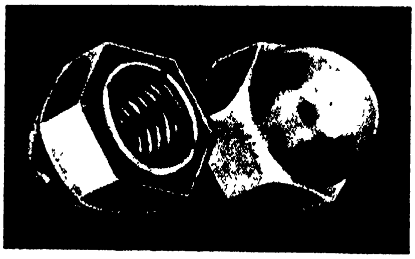
Another war-time metal replacement

line accomplishments of Plexiglas, which in itself plays an important military role in the form of transparent observation sections and turrets in bombers and fighters. One of its latest uses is in a knife sheath which fastens to the belt of packing-house workers; aluminum was previously used in order to reduce weight. The new sheath, formed from scrap pieces of aircraft plexiglas, is even lighter in weight than the aluminum, can be easily washed, has a sanitary appearance, and is extremely tough.

LOCK NUT

Locks to Bolt, Not to Work

A ONE-PIECE lock nut which anchors the nut firmly to the bolt and not to the work is shown in one of the illustrations in this column. These An-cor-lox lock nuts are provided with a locking ring permanently inserted and forming an integral part of the nut. This ring is of a soft, non-springing metal which, when the nut is drawn up to the required tightness, spreads and flows inward around the bolt threads. This locking ring stays deformed even after removal and offers positive drag which prevents the nut from working off under conditions of vibration or shock.


Locking ring prevents "walking off"

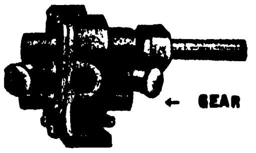
SPEED IRON

Soldering Heat Reached In Five Seconds

A NOVEL departure in the design of soldering irons is shown in one of the accompanying photographs. The heating element of this unit is a loop of No. 11 copper wire, the ends of which are held firmly in place by means of two removable plugs. Contained in the housing just above the grip of the iron is a transformer, designed to operate on any standard 110-120 volt A. C. circuit. When the trigger in the handle is pressed, current from the transformer flows through the loop of copper wire, bringing it to soldering heat in an average of five seconds. The trigger switch is so arranged that

IMMEDIATE DELIVERY
LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS



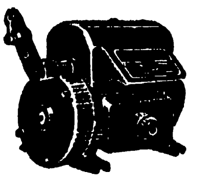
	Inlet	Outlet	Price	With A. C. motor
No. 1 Centrifugal	¼"	⅛"	$ 6.50	$25.00
No. 4 "	¾"	½"	12.50	32.00
No. 9 "	1¼"	1 "	16.50	35.00

No. 1½	Gear	⅛"	Price $ 9.00	With A.C. motor	$25.00
No. 2	"	¼"	" 10.00	" " "	27.50
No. 3	"	⅜"	" 11.50	" " "	28.50
No. 4	"	½"	" 13.50	" " "	32.00
No. 7	"	¾"	" 15.00	" " "	37.50
No. 9	"	1 "	" 18.50	" " "	49.50
No. 11	"	1¼"	" 48.50	" " "	on request

HEAT REGULATOR OUTFIT

Complete with Accessories! $21

GEH Economy Special! —The finest two-piece outfit on the market. Consists of an all electric Minneapolis Control Motor and a General Electric Thermostat. Motor is operated off your nearest light socket and has a built-in transformer supplying low voltage to the room thermostat. The thermostat is adjustable from 50° to 80°.



Easily installed on any type furnace.

Small Piston Type Air Pump

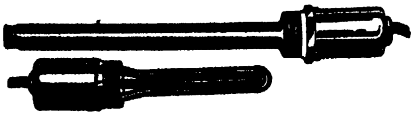
Can be used for all purposes where low pressure air is required. Develops 1/3 cu. ft. of air at 15 lbs. pressure. Suitable for aquariums Takes care of 6 to 8 tanks. Piston type, all brass cylinder Belt driven. Universal AC-DC motor. Mounted on neat base. Complete. $7.95

DURAKOOL MERCURY SWITCHES

This metal mercury switch overcomes faults of usual mercury switches. May be turned a full 360°. Has thousands of known applications from tiny lab instruments to gigantic power controls.

1 Amp.	$1.10	20 Amp.	$3.15
3 Amp.	1.65	35 Amp.	5.50
5 Amp.	1.65	65 Amp.	11.00
10 Amp.	2.00	200 Amp.	50.00

General Electric Immersion Heaters



Suitable for heating liquids tanks, kettles, etc. (1 KW raises temperature 100° F 3 gallons per hour) Fitted for 1½" iron pipe thread Can be used as 110, 220 volt or 3 heat 110 volt.

600 Watt	$7.50	1200 Watt	$10.50
750 "	7.50	2000 "	12.50

3000 Watt ... $15.00

Synchronous Motors

New Emerson 100th H P, 900 R P M 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount, no base Has many applications .$7.50

EXHAUST FANS, BUCKET BLADES
General Electric A.C. 110 volt motors.

	R.P M	cu ft. per min.	Price
9"	1550	550	$12.00
10"	1500	550	12.50
12"	1750	800	18.00
16"	1750	1800	21.00
16"	1140	1650	27.50
18"	1750	2500	22.50
18"	1140	2100	32.00
20"	1140	2800	36.00
24"	1140	4000	42.00
24"	850	3800	45.00

Other voltages & frequencies available at slightly higher prices.

HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

Models D H G ¼

12" x 24" tank A.C. 110 or 220 v. 60 cycle $57.50

16" x 30" tank A.C. 110 or 220 v. 60 cycle $64.50

Large stock of air compressors, ¼ H.P. to 20 H.P. A.C. and D.C., all voltages, 1 to 120 C.F.M. displacement, built for all requirements. Additional data on request.

FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H.P.	R.P.M.	CU. FT. MIN.	INLET	OUTLET	PRICE
0	1/20	1750	160	4½"	3¾"	$22.00
0½	⅛	1750	350	6½"	3¾"	25.00
1	1/6	1750	535	6 "	4½"	30.00
1¼	¼	1750	950	7½"	6 "	37.50
1½	½	1750	1900	9½"	7 "	75.00

PRICES QUOTED ARE FOR A.C 110 V. 60 CYCLES ONLY.
OTHER VOLTAGES ON REQUEST.

PIONEER AIR COMPRESSOR CO., Inc.
120-s CHAMBERS ST. NEW YORK CITY, N. Y.

Plan for "Duration" Living

NO SERVANT PROBLEM
NO TRANSPORTATION PROBLEM
NO OWNERSHIP PROBLEM

SCALED TO REDUCE COSTS, INCLUDING, IMPORTANTLY, COST OF MEALS

The Waldorf offers its "flexible-living" plan for 1942 on three different schedules:

ASTORIA APARTMENTS...one-room apartments that "live" like three rooms...for restricted budgets.

WALDORF ROOMS...large, homelike rooms and distinctive suites for individual or family living.

THE TOWERS...distinguished apartment-homes... 2 to 8 rooms...complete privacy...service pantries.

Astoria Apartments, Waldorf Rooms and homes in The Towers are serviced by The Waldorf's skilled staff...including many tried-and-true employees from the original Waldorf. Concrete and steel, The Waldorf is one of the staunchest buildings in New York. On guard day and night are trusted employees, all U. S. citizens...all bonded.

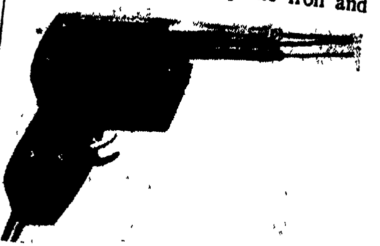
BOOKLET ON REQUEST

THE WALDORF-ASTORIA

PARK AVENUE · 49TH TO 50TH · NEW YORK

when the operator releases his grip on the iron the switch cuts off.

The manufacturer of this "Speedy Iron," Weller Brothers, states that the speed of action is such that there is virtually no waiting for the iron to attain heat. It requires an average of five seconds to pick up the iron and place it on the work; the soldering tip is ready for operation by the time this has been accomplished. Since a standard type of wire is used for the tip, replacements are easily made.



Gun-like soldering iron heats quickly

GOLD LEAF

Production Aided by Air Conditioning

ONE of the most ancient arts and one of America's 20th Century industries have joined hands to facilitate the production of gold leaf, used in innumeraable phases of modern life.

In order to obtain uniform gold leaf so thin that a pile of 1200 sheets is thinner than a sheet of writing paper, Hastings and Company, Philadelphia, one of America's oldest gold beating firms, utilizes Carrier air conditioning. For centuries, gold beaters, among the most skilled craftsmen in the world, were faced with the fact that variations in temperature and humidity caused the production of variable gold leaf. Goldbeater's skin for example, between which the fine sheets of gold are pounded, is exceedingly sensitive to moisture and its characteristics change if it becomes too moist or too dry.

Air conditioning equipment in the Hastings and Company plant, maintaining the temperature at 80 degrees and the relative humidity at 50 percent regardless of outside weather conditions, has made a modern contribution to this ancient art.

SOUND HELPS

Installations Made by Railroads, Ship Yards

THE American railroad system, hard-pressed under war emergencies, is being helped in its job of transporting men, war material, and the necessities of civilian life by a number of new sound installations recently made by

RCA. The Illinois Central is using sound to direct operations in one of its most important classification yards, and has installed complete radio and paging facilities on its new "Panama Limited." The Michigan Central is increasing the efficiency of its Detroit terminal by the use of a complete sound installation. A comprehensive system has also been installed by the Chicago-Northwestern Railroad in its Chicago offices and yards, while the Pennsylvania is putting special sound equipment in 40 coaches.

Among other important new sound installations is a "military" mobile public address system placed at the Tank Destroyer School in Texas. This unit is mounted on a trailer which can be moved to any part of the camp where it may be needed for both instruction and entertainment. So successful has been the installation that the first unit has been enlarged and expanded in usefulness.

A southern shipyard is using sound equipment to carry the ceremonies of launchings to all parts of the yard, so that employees can know what is happening without leaving their jobs. A second southern yard is using sound for communication between shore and ships being moved about from dock to dock during fitting operations. A measurable increase in efficiency has been noted.

BELT AT AXIS

Inflated With CO_2, Has Auxiliary Mouthpiece

Designed to cope with today's sea hazards, a two-pound self-inflating life belt is now under production at a B. F. Goodrich plant. In one of our photographs is shown a rack of these belts awaiting test in a water tank. In use, the belts are inflated by a carbon-dioxide cartridge, but a mouthpiece and tube is attached to each of two rubberized chambers to enable wearers to maintain buoyancy when necessary.

It floats, and supports the wearer

VELOMETER

For Direct Measurement of Velocity of Air Streams

Air conditioning systems, both winter and summer, which require the use of forced air ducts, have developed a need for simple and accurate means of measuring air velocities. Thus, air conditioning engineers, architects, and others concerned with the distribution of cooling or warming air, will find many uses for the Alnor Velometer, shown in one of its forms in an accompanying photograph.

Indicates air currents on scale

In this instrument, which may be used with a variety of jets for application to different air measuring problems, there is a vane to which a pointer is attached, hair springs to control the vane, and a magnetic damping system.

It is unnecessary to include the time element in measurements with this instrument, as the pointer indications are a direct measurement of air speed.

• • •

MOTHS—One female moth and her decendants in a single year, if unmolested, can destroy as much wool as 13 sheep can produce in the same period.

• • •

WINDOW CURTAINS

Stop Light and Flying Glass Splinters

Reinforced felted cattle hair is now being used to produce a blackout curtain which also serves as protection against flying glass. The reinforcement is in the form of wire mesh or a fabric center, and the curtain material is supplied in rolls measuring nine or twelve feet in width by 50 feet in length. Known as Ozite, this felted hair curtain is manufactured by American Hair & Felt Company.

To Get on Top in Your Job

BOOKS

READING ENGINEERING DRAWINGS
G. F. Bush
60 pp. illus. 8½ by 11. *$2.00*
Airplane drawings, machine and structural drawings are covered in detail. Fundamentals common to all branches of the field are stressed. Actual manufacturers' working prints are included among the drawings.

AIRCRAFT ENGINE MAINTENANCE
Lieut. James H. Suddeth
374 pp. illus. 6 by 9. *$2.75*
Careful instruction on the operating and construction principles of the aircraft engine and accessories, as well as detailed study of maintenance procedure. Practical workable information.

AIRPLANE MAINTENANCE
Hubert G. Lesley
511 pp. 384 illus. 6 by 9. *$2.75*
An authoritative volume, presenting all the material necessary to the airplane mechanic. Materials, construction of airplanes, servicing, testing, are covered clearly and simply.

PRINCIPLES OF RADIO
Keith Henney Fourth Edition
549 pp. 310 illus. 5½ by 8½. *$3.50*
A favorite with beginners. The recommended text for the course sponsored by the U. S. Office of Education and the U. S. Signal Corps. Guides the student in easy stages to a working knowledge of radio.

ESSENTIAL MATHEMATICS FOR SKILLED WORKERS
Harry M. Keal and Clarence J. Leonard
Trade Edition
317 pp. 218 illus. 4⅞ by 7. *$2.00*
Covers review arithmetic, geometry, algebra, trigonometry and applied technical problems.

STRENGTH OF MATERIALS
Mansfield Merriman. Eighth Edition Revised by E. K. Hankin
148 pp. 71 illus. 5½ by 8½. *$1.50*
An old standby in modern dress. The material has been condensed and brought up to date, and now includes information on materials such as plastics and aluminum.

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If I decide to keep the books I will remit their list price; otherwise, I will return them postpaid.

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THE HENRY SYSTEM Of Finger Print Classification and Identification

is now in use by most of the Police Departments in the United States. It is also the system which applicants for many Civil Service positions must master before they can successfully fill all requirements.

The only book based on the Henry System is Frederick Kuhne's

"THE FINGER PRINT INSTRUCTOR"

In this 182-page book, written by a noted finger print expert who was for many years in the Bureau of Criminal Investigation, New York Police Department, will be found complete instructions on every phase of the work from taking the prints to final identification. Numerous photographs and reproductions of prints make all details clear.

Used by many governmental and industrial personnel departments and by the F.B.I.

$4.25 postpaid

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the information you need for the accurate design and construction of any mechanical device. Get the book that, in its latest edition, presents 2987 practical drawings, with accurate, understandable descriptions, of mechanical movements, devices, appliances, and so on, used in machinery for every conceivable purpose.

"THE ENGINEER'S SKETCH BOOK OF MECHANICAL MOVEMENTS"

By Thomas W. Barber

$4.35 postpaid

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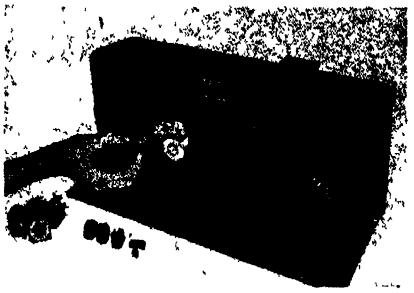
Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

MARKING MACHINE

Uses Acid Dye to Make Permanent Mark

Ink marking of tubular parts such as collars, rings, flanges, and so on is simplified with the new motor-driven machine shown in one of our illustrations. The marking may be applied to either smooth or sand-blasted finishes.



Speedy and easy to operate

A marking speed of as high as 30 pieces per minute can be attained under ordinary conditions. In operation, the part is placed by hand on a protruding mandrel and the rotating die imprints the mark, whereupon the part is automatically ejected.

The ink used in this marking machine, manufactured by the Acromark Corporation, is a liquid dye with an acid content, dissolved in alcohol. The slight amount of acid in the dye quickly exhausts its energy after having etched the surface sufficiently to cause the dye to adhere permanently. The etching is so slight that the ink does not injure the surface nor is it dangerous to use.

It is claimed that marks made with this machine remain permanently in weather and handling tests as well as salt water, gasoline, and oil tests.

SAFETY SOLVENT

Developed to Replace Naphtha, Gasoline, Kerosene

A new hand-wiping safety solvent which is to be marketed as a safety replacement for naphtha, gasoline, and kerosene in removing cosmoline from rifles issued to troops, is also applicable for industrial use as a naphtha substitute for grease cleaning and hand-wiping operations in ordnance factories or shell plants. The new solvent, developed by The Curran Corporation, is marketed under its blanket trade-mark of Gunk XP-92; it is to be used as a concentrate and to be diluted with water.

This new solvent, in spite of its high solvency against mineral oil or dirt, does not de-oil the skin, has no toxic vapors, no flash or fire point, and leaves a rust preventive film so thin it cannot ordinarily be detected.

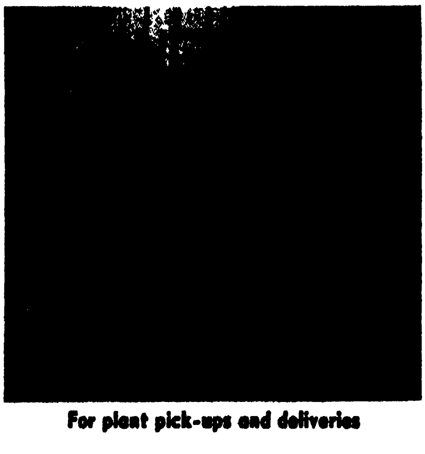
SHOP TRUCK

Motorized, Carries Loads to Half a Ton

Powered by a single cylinder, four-cycle gasoline engine which develops over 7½ horsepower, a simple friction-drive truck is now available for industrial transportation. The body of this truck is so designed as to conveniently carry bulky material, boxes of parts, or long bars and tubes. The rear of the truck can be quickly fitted with seats so as to make the unit available for transporting officials and visitors around large plants.

The steering of this vehicle, recently announced by The Buda Company, is accomplished by one hand through an easily operated lever. The truck will turn completely around in a seven foot, three inch radius and, because of its three-wheel construction, can be maneuvered easily in narrow aisles.

Engine and gasoline tank are located under the seat, which can be quickly



For plant pick-ups and deliveries

thrown back to provide access to the entire power unit and drive. The brake is so arranged as to be controlled by a conventional pedal or to be automatically applied the instant that the operator leaves his seat.

PROTECTIVE OIL

Removes Surface Impurities, Prevents Corrosion

Oil which is claimed to have the valuable property of completely removing perspiration, water, oil, and dirt from steel surfaces is known as Polar K, and is a development of The Curran Corporation. The new oil is said to be superior to alcohol for dehydrating and cleaning steel surfaces, bearings, or similar parts which have become wet or have been left with a film of grinding emulsion. It instantly displaces and absorbs water and leaves a thin film of lubricant and rust preventive. The Polar oil is completely soluble in hydrocarbon and lubricating oils and no subsequent cleaning procedure is necessary to remove the film.

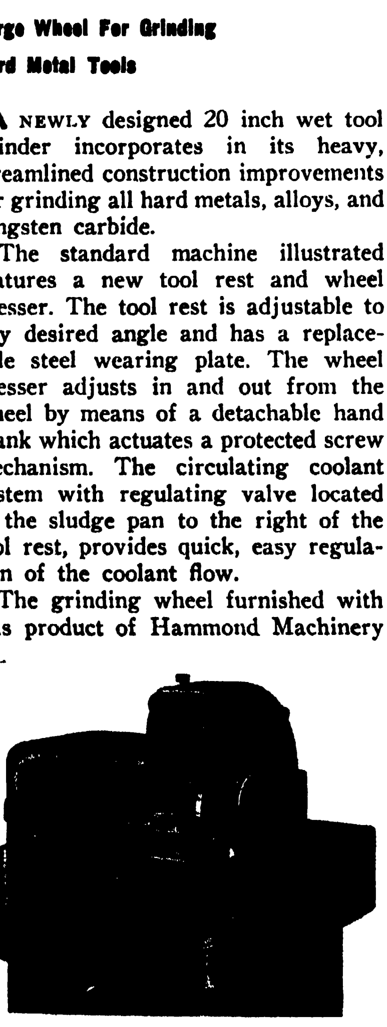
WET GRINDER

Large Wheel For Grinding Hard Metal Tools

A newly designed 20 inch wet tool grinder incorporates in its heavy, streamlined construction improvements for grinding all hard metals, alloys, and tungsten carbide.

The standard machine illustrated features a new tool rest and wheel dresser. The tool rest is adjustable to any desired angle and has a replaceable steel wearing plate. The wheel dresser adjusts in and out from the wheel by means of a detachable hand crank which actuates a protected screw mechanism. The circulating coolant system with regulating valve located in the sludge pan to the right of the tool rest, provides quick, easy regulation of the coolant flow.

The grinding wheel furnished with this product of Hammond Machinery Builders, Inc., is 20 inches in diameter by 2½ inch face with a 9 inch hole for mounting on a large-hole wheel flange. The heavy cast wheel hood with hinged cover provides easy and quick wheel changes.



For heavy duty, high production

VARIABLE SPEED

Built Into Pulley On Motor Shaft

Infinitely adjustable over a three-to-one ratio of speed ranges for motors from fractional to five horsepower, a new self-contained motor pulley forms the actual drive element between the motor and the driven shaft. Thus all auxiliary equipment such' as chain drives, gears, and so on are eliminated.

Not steps in speed, but any speed

This variable-speed device, manufactured by Reeves Pulley Company, consists of an assembly of two facing cone-shaped disks. One is stationary while the other slides laterally and is loaded by an adjustable compression spring. This whole assembly is mounted on any standard motor shaft. A motor base with an adjusting handwheel is also an essential part of the variable-speed drive. By means of this handwheel the motor, and hence the disk assembly, may be moved forward or backward. By means of this motion, the special V-belt used for driving is made to contact a changing arc on the disks. Thus, when the motor is nearest the driven pulley, the V-belt is at the largest arc of contact and maximum speed is obtained on the driven machine. Turning the handwheel so that the motor moves away from the driven shaft causes the V-belt to run over a smaller arc of contact and to reduce the speed.

With this pulley, belt, and motor base arrangement speed adjustability is infinite between maximum and minimum. Changes are made while the driven machine is running, and any required speed is accurately maintained as long as desired.

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A Troopship Of The Sky

Cargo Planes of the United States Army Are Now Carrying Troops, Jeeps, Trucks, and Military Supplies

ALEXANDER KLEMIN
Aviation Editor, Scientific American Research Professor, Daniel Guggenheim School of Aeronautics, New York University

THE Germans were the first to grasp the tremendous possibilities of the theory that greater mobility in both offensive and defensive warfare could be secured by transporting troops and weapons by airplane. Their Junkers 52, a relatively slow and plodding but roomy and reliable type of plane, has been carrying supplies, weapons, infantry, and parachutists to Norway, to Libya, to the Russian front.

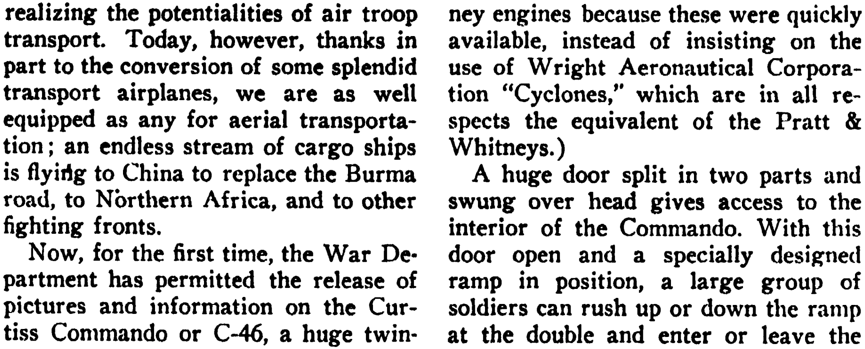
Our own Air Corps, or let us say rather our Army, was a little slow in realizing the potentialities of air troop transport. Today, however, thanks in part to the conversion of some splendid transport airplanes, we are as well equipped as any for aerial transportation; an endless stream of cargo ships is flying to China to replace the Burma road, to Northern Africa, and to other fighting fronts.

Now, for the first time, the War Department has permitted the release of pictures and information on the Curtiss Commando or C-46, a huge twin-engined airplane which originated as an airliner, and on which $2,000,000 has been lavished in five years of development and research. The Curtiss Commando has a wing span of 108 feet, a gross weight of 50,000 pounds when fully loaded, and is powered by 2000 horsepower Pratt & Whitney engines. (It is a sign of the fully cooperative spirit of the times that a Curtiss-Wright subsidiary readily accepted the installation of Pratt & Whitney engines because these were quickly available, instead of insisting on the use of Wright Aeronautical Corporation "Cyclones," which are in all respects the equivalent of the Pratt & Whitneys.)

Special ramp permits rapid entry and exit of soldiers and vehicles

A huge door split in two parts and swung over head gives access to the interior of the Commando. With this door open and a specially designed ramp in position, a large group of soldiers can rush up or down the ramp at the double and enter or leave the spacious interior of the huge ship. The Commando can carry many other things than large bodies of men. Jeeps, for example can be driven up the ramp and right into the cargo compartment.

No details are given as to size or useful load of this transport, but we do know that the plane was originally planned as a 36-passenger luxury liner. Soft upholstery, roomy seats, wide aisles, and convenient lavatories


Windshield of pilot's cockpit in Curtiss Commando blends imperceptibly into streamlined fuselage. Small windows replace normal lavish window space of the airliners

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have now given way to the vast interior of the cargo cabin. In one of our photographs is seen a "jeep" in the cabin, together with a number of fully equipped infantrymen occupying specially designed side seats.

The all-metal frame of the commando has been specially reinforced to accommodate heavy concentrated loads such as artillery, army tractors, trucks, aircraft engines, aviation gasoline, and other equipment and materials which may be required by a modern Army. That such reinforcement may well be necessary will be clear when we remember that in maneuver and under the action of gusts the dead weight of a two-ton truck may be multiplied into an effective, although temporary, weight of 10 tons or more.

While the Commando lands much more slowly than pursuits or bombers, as may be vitally necessary when landing in rough fields, and flies more slowly than such speed demons, it has managed to span the Atlantic in a non-stop flight of little more than nine hours.

To illustrate the cargo-carrying capacity of the Commando we are given this interesting piece of information by Burdette S. Wright, Vice-President in charge of the Airplane Division of Curtiss-Wright. "Twenty-five transports of this type would have transported all of the estimated 30,000 tons of material carried by 7700 trucks over the tortuous Burma Road during an entire month."

Commando's reinforced fuselage supports both troops and jeeps

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At Service Centers

RECREATION centers for service men on leave have been set up in several places in New York City and in other parts of the country as well. Some of the visitors, whether of American, English or other nationality, make unusually fine subjects, especially when rigged out in their service costumes. Occasionally, one meets very unusual characters, such as the 16-year-old English lad here pictured. Flash is the only practical lighting to use, in most of these cases; this one was taken with a single flash off the camera. Placing the figure against a dark flag made for a striking arrangment, and the lively expression gives the picture animation.

"Eddie, of the Royal Navy"

New Varigam Filters Cut Printing Time

A NEW type of filter for use with Defender Varigam enlarging paper has been introduced to cut the printing time without impairing contrast or other qualities. The new filters, which reduce the exposure time by half, are identified by the letter "F" following the usual designation, which now reads, for example, VG-3F. Filters nos. 9 and 10 remain unchanged, however.

Birds in Color

AN amateur ornithologist's color flash shots were recently exhibited at the Bronx Zoo, New York, where they were admired both by photographers and ornithologists—for their excellent technique by the first and their fidelity to colorings by the second. Dr. Eliot Porter, of Hubbard Woods, Illinois, who made the pictures with the aid of a Guggenheim Foundation Fellowship in Arizona and Illinois last year, achieved good results by adopting a standard technique: employing a 9 by 12cm Linhof equipped with an 18.5cm Zeiss Protar in a Compur shutter, and a Kalart Micromatic synchronizer, he shot Daylight Type Professional Kodachrome at *f*/18, with two G.E. No. 21B flash bulbs in 11-inch Victor aluminum reflectors, one on either side of the camera, with their rims 18 to 20 inches from the subject.

Incidentally, bird photographers may be interested in the standards Dr. Porter has adopted in his work:

"First, the birds must be neither out of focus nor blurred by motion; second, they must be identifiable insofar as is possible within the limitations of black and white representation; third, all other essential parts of the picture must also be in good focus and recognizable; fourth, pictorial standards of composition and execution must not be relaxed."

"Bleed" Prints

SOMETIME back someone approached us with an easel idea for making bleed prints—pictures without white borders—in which a great many criss-crossings of Scotch tape were to be employed to hold the paper in place during enlarging. The idea seemed rather impractical from several standpoints. However, we now see that someone is actually using a greatly simplified adaptation of the idea that serves the same purpose, without the necessity of purchasing a special easel. All he does is attach several strips of Scotch tape to his regular easel, sticky side up. You put the paper down and it sticks, flat overall.

Silhouette in a Gallery

SILHOUETTES have many variations A bed sheet is a doorway with a light behind it and the subject in front is not the only way to shoot silhouettes. The accompanying one was taken from the

"Silhouette"

entrance to an art gallery, with a lady on a couch nonchalantly pulling on a cigarette as the unobserved photographer made his shot at *f*/6, 1/25 of a second. Two fluorescent lights illuminated the pictures on the wall; the lady, near the door, was almost completely in shadow. A straight print produced this result.

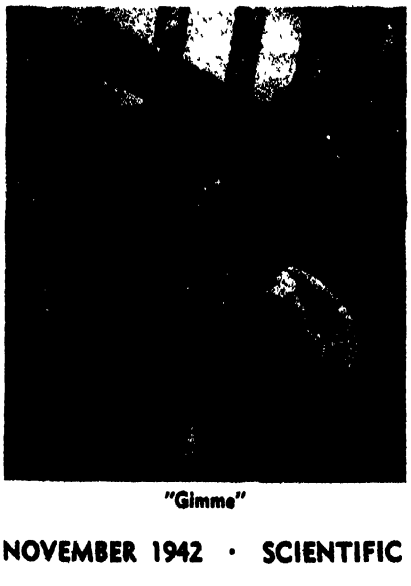
How Far from Subject?

What is the correct distance between subject and camera for good perspective? This is a question that seems to bother a lot of people. The advice ranges anywhere from six to 12 feet. But there's a scientific rule that settles the matter not only for portraiture but for other subjects as well. Measure the distance from the part of the subject nearest the camera and the part farthest away; then multiply this distance by eight. The result is the distance at which the camera should be placed, measured from the nearest plane.

Thus, if the distance between the two limiting points of the subject is one foot, the camera should be eight feet away from the nearest plane. In the case of a head portrait, the distance might be five or six feet. If the image is too small, use a lens of longer focus, if this is available, or enlarge the wanted part of the image

Zoo Epitome

The simplest elements still make the most striking pictures. We don't have to see the elephant, nor the child in this picture to appreciate completely the familiar but always exciting experience recorded for us in the illustration by David B. Eisendrath, Jr., staff photographer for *PM's* Picture News. Part of a recent exhibition at the Bronx Zoo, the picture invariably brings a smile from both young and old, for who has not at one time or another offered peanuts or popcorn to the zoo elephant in return for the delightful experience of watching this favorite zoo attraction stretch forth his great, yawning snout to receive it? By concentrating his lens on essentials, Mr. Eisendrath has created a sort of symbol that fetches a universal response. The extremely shallow depth of field is due to the use of a 17-inch lens on a 4 by 5 Graflex, but note how the close view lends drama, life, and uniqueness to what might have proved just another shot of an already too familiar subject.



"Gimme"

Auto-Tire Frame

Now that automobile tires have become so precious, why not take that spare into the house some time and use it as a photographic prop? As a frame, for example, per the illustration. A white-walled tire is best. The tire was placed on a box covered with black cloth, the lady put her head into the circle as well as she could and held the tire upright. One light at a 45-degree angle for general illumination and another very low in front to take care of the shadows, completed the lighting scheme.

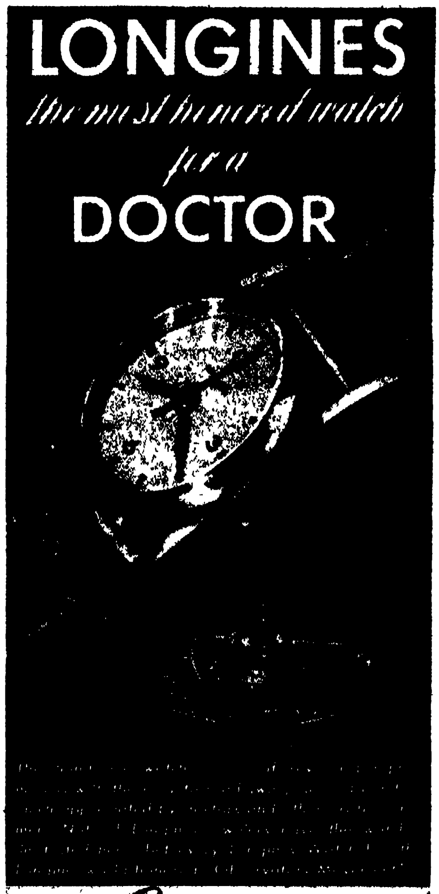
Lady and the Tire

Typing On Glossy Prints

Should you have occasion to typewrite on glossy photographic paper, we understand there is a ribbon specially produced for this purpose. It is called "Clear Presidential Silk Litho No. 3, Special Ribbon," and is available from the distributors, Stanley W. Arend Company. When ordering, it is necessary to specify spooling and to give the make and model of the typewriter.

Have You Tried Proof Paper?

In the title we do not refer to the proof paper which produces the familiar reddish-image that is here today and gone tomorrow, but to the so-called Portrait Proof Paper produced by Eastman. Single weight, developing-out type, slightly slower in printing speed than Vitava Projection, Portrait Proof is intended for making proofs by contact, with reduced illumination, or by enlargement. Supplied in matte and luster surfaces in one degree of contrast for normal negatives, this paper has such a pleasing surface and produces an image of so fine a quality that it is steadily becoming rather popular as a medium for the finished print. Particularly suitable for soft portrait results and pictorial studies, Portrait Proof lends itself beautifully to toning.



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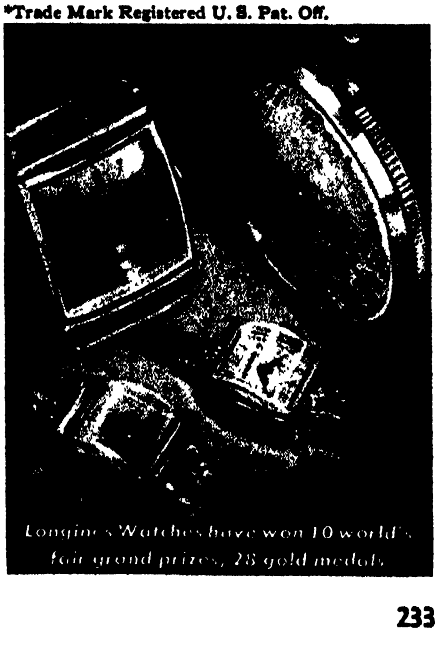

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(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below)

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Seeing in the Blackout is an eight-page illustrated bulletin giving details of phosphorescent and fluorescent materials which are commercially available for use in the home and elsewhere These materials, in sheet form, can be cut to size and nailed or cemented wherever luminous indicators are needed. *Continental Lithograph Corporation, 952 East 72nd Street, Cleveland, Ohio.—Gratis.*

Accident Facts—1942 Edition is a 116-page statistical yearbook which gives most of the answers to safety problems. This book was listed in this column in our October issue as being available gratis Instead, it should have been noted that a charge of 50 cents a copy is made in quantities up to ten copies. *National Safety Council, Inc., 20 North Wacker Drive, Chicago, Illinois.*

Reference Guide to Ultra High Frequencies is a 52-page bibliography covering 593 articles on ultra high frequency and associated subjects. *Miss E. Kelsey, Zenith Radio Corporation, 680 North Michigan Avenue, Chicago, Illinois.—Gratis.*

A Preliminary List of Foreign Periodicals Currently Available on Microfilm is an eight-page booklet which is precisely described by its title. *Microfilms, Inc., 313 N. First Street, Ann Arbor, Michigan.—Gratis.*

Civilian Conservation of the B.T.U. is a 24-page manual dedicated to users of equipment who want the continued benefits of their air conditioning, refrigerating, and heating systems. The book serves as a handy reference guide to the simple care of existing equipment. *Carrier Corporation, Syracuse, New York.—Gratis.*

Plastics From Agricultural Materials, by O. R. Sweeney and L. K. Arnold, is a 52-page bulletin which reports the results of several years of research on plastics of high impact strength and low water absorption. Four plastic products were studied, all of which showed definite commercial possibilities. *Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.—Gratis.*

Boost Production Through Increased Employee Morale is a special report designed to help executives to make an inventory of working conditions, of management policies, and of their workers, all aimed at possible production increases and better employee morale. *Labor Relations Institute, General Motors Building, New York, New York—Gratis*

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Some Factors Influencing the Heat Output of Radiators is a 16-page booklet which gives comprehensive engineering data on the most important of the factors involved. Bulletin Number 29. *College of Engineering, Cornell University, Ithaca, New York.—25 cents*

Mounted Wheel Manual is a profusely illustrated booklet which gives detailed instructions on the operation of mounted wheels and accessories, specially designed to fit perfectly into the industrial war pattern. Content of the booklet includes a selection guide, giving detailed information on the application of mounted wheels. Another section is devoted to mounted polishing wheels. *Chicago Wheel & Manufacturing Company, 1101 West Monroe Street, Chicago, Illinois.—Gratis.*

South Bend Lathe Catalog No. 100-B is a 48-page illustrated brochure which describes this entire line of engine lathes, toolroom lathes, and turret lathes. Machine specifications are tabulated to facilitate the selection of the lathe required for any desired application. *South Bend Lathe Works, Dept. S7, South Bend, Indiana.—Gratis.*

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

Mosquitoes in summer, and cold in winter. Most amateur astronomers put up with these troubles in observing because the construction of a warmed observatory room, such as those described by Porter and others in "A.T.M.," is relatively formidable. One such type is the turret telescope and of these there are now about half a dozen. One of them, warmed electrically, has just been constructed by Roelof Weertman, of Dutch descent, member of The Amateur Astronomers Association of Pittsburgh, residing at Division Lane, Observatory Hill, Vanport, Pa., 25 miles north-west of Pittsburgh (mailing address, R.F.D. 1, Beaver, Pa.), and is shown in Figures 1, 2, 3, and 4. This is a larger, heavier, more elaborate installation than the illustrations at first suggest, the parts above the roof-line alone weighing 1500 pounds.

The telescope itself, when examined closely, proves to be more conventional in type than the first glance suggests. It is a simple, ordinary Newtonian, 12½" in aperture, an $f/9$, its 100-pound counterweight being carried on an extension of the tube rather than in separate form. This makes the tube 14' long. There are no added reflections—no siderostat as, for example, at Stellafane's turret telescope. This, of course, entails reversing the dome—toward the building as shown.

In this type of telescope the observer within the dome looks into an eyepiece which lies *in* the declination axis. He also stands within the polar axis, which is expanded into a big ring to permit his entrance into it.

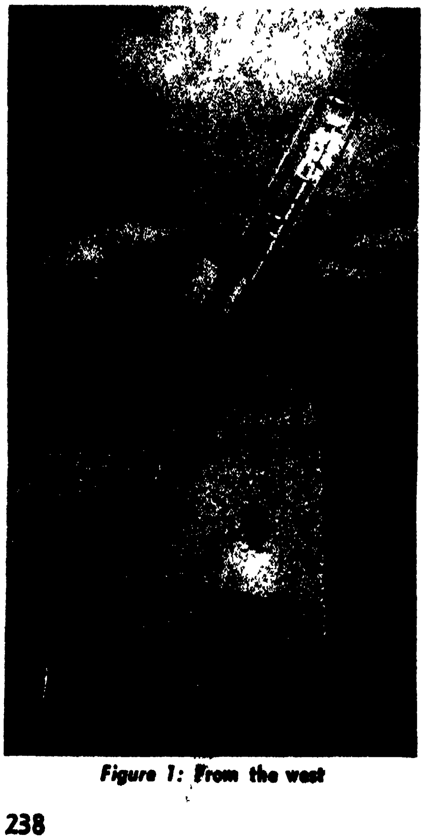


Figure 1: From the west

Starting at the bottom and working upward, as in the actual construction, we have in this telescope the following catalog of elements.

A reinforced concrete foundation on bed rock.

A hollow tile building of dimensions shown in Figure 4—narrow enough (56") to permit the tube to reach the zenith on either side.

A 2" plank floor and a 2" plank roof deck, the latter covered with tinned iron and painted.

Inside the building a stairway, as shown (Figure 4). This is only 24" wide and is on the side nearer the reader. At its head is a trap door 24" wide, and beyond this a fixed section of platform also 24" wide. The entering observer pushes up the trap-door, climbs up on the fixed platform, lets the trap-door down, and thus is on a platform 33" wide and 48" long. There is ample room for two observers, but three's a crowd. Well, sometimes.

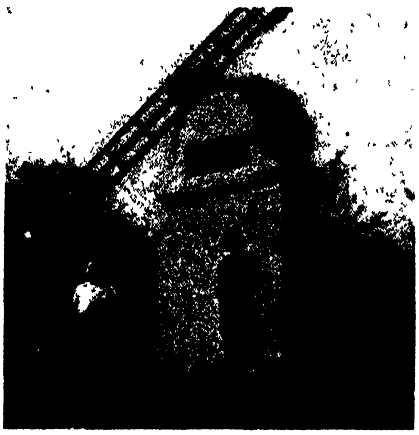


Figure 2: From the south

Surrounding the rectangular opening through the roof deck, where the dome emerges, a large, rectangular, horizontal, iron base, 51" by 33".

Welded to this, four upright struts of 2" pipe, to carry the tilted ring.

Fixedly welded to these four supports, a 315-pound ring of 50" inside diameter, made of 3⅝" by 4⅛" angle iron, and slanted at 49°15'. The web space between the basal rectangle and the fixed ring is filled in with metal lath and plastered inside and outside with 2" of concrete, through which there is a window (Figure 2) 14" by 27".

Bolted to the fixed ring, three 3⅛" ball-bearing rollers from automobile rear axle housings.

Pressed on one of these three rollers a 10" worm wheel to provide the friction drive to rotate the dome (done by an automobile window crank).

Figure 3: From the north

At right angles to these rollers, two 4⅜" thrust bearing rollers to prevent the movable ring and its attached telescope from slipping off.

A 215-pound movable ring of 3⅝" by 4⅛" angle iron. This carries the telescope, the dome, and the hour circle.

Welded on the movable ring a 2' length of 4" by 6" angle iron, as a base, and on this a square piece of 12" flange beam, stood on end. This unit carries the mounting for the tube, also a declination slip plate, eyepiece holder, holder for 2½" elliptical flat, declination and setting circle, declination worm, and ball bearings. A blueprint of these details may be had gratis from the owner.

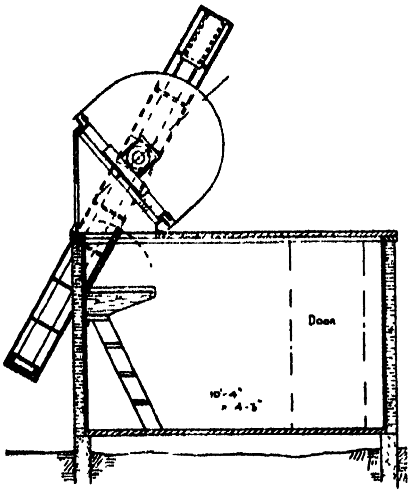
In its swing, or traverse, the eyepiece does not rise more than 1' above its lowest (E. and W.) positions.

On the above unit the tube, 14" inside diameter, built of 1" by 1" tee-bar straights and 1¼" by ¼" by ½" hoops.

At its upper end the tube carries a 100-pound counterweight.

Attached to the movable ring a dome of galvanized, riveted, sheet steel. Its interior is marked with latitude and meridian circles. Prominent stars and nebulae are indicated on it, with their R.A. and Dec., so that these and other landmarks can be found instantly.

A 12½" mirror which, before silvering, was subjected to the criticism of Norbert



Redrawn bv Russell W. Porter

Figure 4: Side elevation

J. Schell, Beaver Falls, Pa., of off-axis and criss-cross off-axis telescope fame.

When the telescope is not in actual use, the mirror is left in it covered by a latched lid. A 3' sack, like a big mail-sack (Figure 3), is drawn over the end of the tube as a protection against rain, and the tube is then turned mirror end up.

The 300-pound tube unit, including the tube's own 100-pound counterweight, is hung on one side of the movable ring. This is balanced by a 570-pound counterweight mounted inside the dome opposite the telescope.

In the photographs (Figures 1, 2, and 3) are seen respectively: Weertman; Billy Weertman, Mrs. Weertman; John Cool, Billy again, and at ground level, Mrs. Weertman again with Betty Tulip Weertman, Billy's goat (not, however, a billygoat). All—especially Mrs Weertman—assisted in the work, even Betty That is, when anybody made a mistake, Betty was the goat

Weertman says the observatory once served as a fort. No sooner had he finished the concrete doorstep than a "halitosis kitty" ambled up, drove him inside, and left his or her footprints in the soft concrete.

Altogether, this is a notable telescope

PARTIAL silvering, sometimes spoken of as half-silvering, is sometimes desired for optical instruments. Accomplishing it by the familiar Brashear process often requires agility and involves an element of uncertainty, since the silver ordinarily is deposited too quickly to permit calm, steady observation and quantitative control Two readers of this department, Dr. Henry Paul, of the Norwich Pharmical Company, a chemist, and Dr. Wilbur Silvertooth, of Paramount Pictures, Inc., a physicist—both amateur telescope makers—have called to our attention a new method of partial silvering originally described in *Industrial and Engineering Chemistry* (May, 1942) by Robert D. Barnard, M.D., of The Chicago Medical School, as follows:

"The surface should be cleaned with hot chromate sulfuric acid solution and thoroughly rinsed with distilled water. It is unnecessary to use the application of

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AIR NEWS

caustic soda so often recommended. If a drop of distilled water will spread evenly over the entire surface, it may be considered free from grease or other organic matter.

"About a half liter of (1) a 10 percent silver nitrate solution containing one or two drops of concentrated nitric acid and of (2) a 10 percent solution of technical triethanolamine are conveniently made up. Both solutions will keep indefinitely.

"The surface to be mirrored is placed face upward in a clean Petri dish of sufficient diameter to accommodate it. To 25 cc. of solution 1 in a large test tube are added 10 cc. of solution 2; then, with constant agitation, further additions are made of 2 or 3 cc. at a time, just to the point where the precipitate which forms on the first addition clears completely The mixed solution is poured immediately over the object to be plated so as to cover it by a layer of at least 0.25 inch. The deposition of silver begins within a few seconds.

"For the half-reflecting surface required for interferometers, a layer of silver which transmits about as much light as it reflects is ideal. Such a layer has a distinct violet tinge and appears within 10 minutes at room temperature.

"For completely reflecting surfaces, the immersion may last for 24 hours; this particular bath is unique in that the deposition seems to be continuous for that length of time.

"The Petri dish gives good visual control of the extent of plating, since deposition of silver occurs only on a surface, and not through the body of the solution. It is possible that the low surface tension of the triethanolamine may be responsible for this phenomenon.

"When the desired thickness is deposited, the plated object is taken from the bath, only the edges being handled."

Dr. Silvertooth, mentioned above, states that "We have used the method here at Paramount Pictures, Inc., with considerable success, in preparing partial transmission films."

Dr. Paul, also mentioned above, suggests caution in adding nitric acid to as concentrated a solution of silver nitrate as is used in the Barnard Method—risk of explosion (see warnings in "A.T.M.," pages 412-415). In this, Dr. Barnard concurs.

The triethanolamine needed is easily obtained through chemical supply houses.

Replying to a private communication, Dr. Barnard emphasizes again that his method was devised particularly for partial transmitting surfaces, and points out that, for full reflecting surfaces which require a heavier coating, the original triethanolamine method developed by Professor M. Meltsner, of the College of the City of New York, described in U. S. Patent No. 1,988,764, is more suitable. "Difficulties will arise in the latter case," he writes, "and the directions in the present article will have to be modified by using a much higher concentration of triethanolamine, even up to a concentration of 90 percent. Because of the difficulties encountered with the variation in composition of commercial triethanolamine solution now available, the method used in the cold, as I described it, requires a certain amount of manipulation for best results. Samples of triethanolamine containing a large amount of volatile alkyl amines (strong fishy odor) should be rejected, as should those with a large amount of chloride present. These do not appear to interfere with the Meltsner Method as much, though the last method is inapplicable to surfaces which cannot be heated."

DRIVE, clean, simple, free from gadgets, and hickerpickers, made by N. J. Schell, 1019 Third Avenue, Beaver Falls, Pa., is shown in Figure 5. Asked to describe it, Schell writes:

"The drive is used with an equatorial which has for its upper polar bearing a large cast iron flange, or plate, which rolls on two ball-bearing rollers (Porter's design, I believe). I found it would be necessary to re-build the whole thing if a worm-wheel was to be used, so tried using a thin band or belt of phosphor-bronze (continuous) which passes around both rollers and under the large flange This band is just taut when the weight is on it.

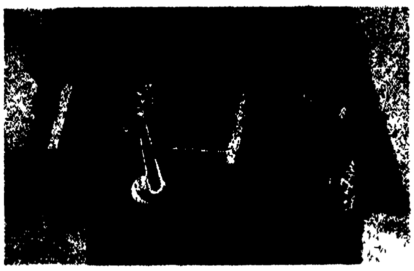
Figure 5: Schell's drive

"The band is pulled by a screw of 12 threads per inch, by means of a nut which has a yoke over the top—the band passing between the top of the nut and the yoke An eccentric pin or shaft enables the band to be clamped firmly to the nut at any point, a simple wrench turning the eccentric pin, as shown. When not clamped, the band can slide freely as the mounting is moved in right ascension.

"The drive begins with a 12-watt Telechron motor which is enclosed in a box below the main plate, continues through a train of helical gears in the narrow box at the right, terminating in the screw The knobbed wheel on the gear box is a clutch to disengage the gears, which is necessary in order to run the nut back on the screw after it has traveled from left to right. This takes only a minute or so and, as it takes about three hours for the nut to travel the length of the screw, a single resetting will take care of an entire evening.

"The whole assembly, with the exception of the band, is in one piece and is attached by the single bolt shown just below the wrench (the pin and yoke are first slipped off, however, and the band remains on the mounting). The base of the assembly is ½" steel plate. The bar below and parallel to the screw serves the dual purpose of tie-rod and guide for the nut.

"There is no claim for originality in this design."

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

WEARING new battle helmets, members of the merchant crew and Navy armed guard aboard ship practice operating a 20 millimeter gun. The crew member in the center of the picture is removing an empty magazine from the gun; the one at the right is prepared to hand over a new one. The canvas bag beneath the magazine catches the empty shells. U. S. Navy Official Photo

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of December, 1892)

CANAL—"At a recent New Orleans convention, which was attended by prominent business men from many sections of the country, the main effort was to bring to bear upon Congress sufficient influence to secure government aid in building the Nicaragua Canal."

STILL BAFFLING—"One of the subjects of invention which seem to have baffled inventors for many years is a practical cotton harvester. . . To a large extent, cotton planters in the South have been hampered by the difficulty in obtaining labor at the right time, and, as a result, serious losses have followed; but at length a machine has been perfected which may reduce cotton harvesting to a certainty. To run this machine, two men and a single team are required. It will harvest from 5,000 to 6,000 pounds of cotton per day at a cost of $3 to $4, as against forty men picking not over 150 pounds each per day at a cost of $30. . . The machine consists of a frame suspended on ordinary wagon gear and inclosed in wire cloth Within the frame are journaled two series of vertical shafts, upon which are placed beaters having spring arms. Through the bottom of the frame extends a slot, through which the stalks of the cotton plants pass. In the bottom of the frame are arranged conveyors which carry the cotton beaten from the plant rearwardly and upwardly, and deliver it to bags attached to the elevators at the rear of the machine. . . One of these machines has been in operation this season in Alabama, yielding the results we have described above."

INFUSIBLE—"Magnesia, formerly chiefly valued on account of its medicinal properties, has recently risen into great commercial importance, owing to its infusibility and its employment as a lining for converters used in the basic process of steel manufacture."

FALLING—"A fall, as a rule, injures a drunken man much less than a sober one, because, the controlling power of the mind being rendered nil through intoxication, the body falls as an inert mass, and thus the chances of injury are lessened, for, strange though it may appear, it is no less a fact that the most numerous cases of injury arising from a fall are caused by the effort, voluntary or otherwise, to avert the consequences, thus straining the muscles and tendons."

BALLOONING—"A very interesting balloon ascension took place at the end of the month of October. Mr. Mallet started at 6 o'clock in the evening of Sunday, October 23, in a balloon of 28,660 cubic feet capacity. . . . The balloon touched earth in the midst of a snow storm at half past 6 o'clock in the morning of Tuesday, October 25. The trip lasted 36 h. 30 m. No balloon has, up to the present, remained so long in the air."

YESTERYEAR—"The National Association of Carriage Builders held their 20th anniversary recently in Buffalo, New York. Among the subjects treated a particularly important one, and interesting in view of the general movement for the advance of technical education, related to the establishment of a carriage builders' technical school. . . Carriage building is rapidly developing and bids fair to become a true profession. The past year has witnessed remarkable results obtained by the introduction of ball bearings and pneumatic tires on racing wagons, and it is hard to believe that the day is not near at hand when vehicles of luxury will be thus equipped."

MATCHES—"If the worthy gentlemen who control a monopoly of the trade in matches in the United States will give ear to reason, they will improve the quality of their product, even if in so doing they have to sacrifice a tithe of their present profits. Some of the matches now sold are a nuisance because of their unreliability, while others are a constant source of danger to property, if not to life, even in the hands of careful people. A portion of these latter drop a portion of the inflammable composition invariably, and if it happens to light on combustible material, a fire is pretty sure to result."

BRITISH NAVY—"By the launch of the Revenge from the works of Messrs. Palmer's Shipbuilding and Iron Company, Jarrow, on the 3d of November, and the floating of the Royal Oak from her building dock at Messrs. Laird's establishment, Birkenhead, the fighting strength of the British navy has been materially increased. These vessels belong to a class of eight, provision for the construction of which was made in the Hamilton Defense act of 1889, and they are considered on all hands to be, as regards strength and power for battle, superior to any first-class battle ships possessed by foreign powers."

ELEVATED—"In the early days of New York elevated railways the man who appears to have most highly appreciated their value and foresaw their great future was Mr. Jay Gould, a Wall Street broker. He bought out the Tilden and Field interests and so gained control of the works. The roads are admirably managed, and their extension in various directions would greatly add to the public convenience"

COLOR PHOTOGRAPHY—"M. Lippmann has been pursuing with energy his investigations into color photography. He says that 'on the layers of albumino-bromide of silver rendered orthochromatic by azaline and cyanina, I obtained very brilliant photographs of spectra. All the colors came out at once, even the red, without the interposition of colored screens, and after an exposure of from five to thirty seconds.' He submitted photographs of stained glass windows, draperies, oranges, and a parrot, taken by electric light with five to ten minutes' exposure, in which the color is noticeable as well as the form."

THE PATH OF WAR

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OUR *Point* OF VIEW

CENSORSHIP

To the foreign readers of Scientific American there is due an explanation of certain oddities which they have recently seen in these pages; to our domestic reader group there is inherent interest in this explanation regarding one of the many difficulties which war places on the publication of a magazine. The oddities referred to consisted of blank spaces in the editorial content of the magazine, sometimes only a few lines in extent, sometimes full pages and more. In these spaces, from which certain articles had been deleted, there appeared a statement to the effect that the material originally scheduled for these spaces was not approved for export by the Office of Censorship.

Compulsory censorship? Restriction of the freedom of the press? Not exactly, in this case, but, rather, a censorship set up for a war purpose and being carried on by a group of men who are doing it with a commendable sense of the responsibility which has been vested in them.

After the editor has made his selection of articles, and has carefully combed it for possible offending material, it is submitted to the Technical Data Division of the Board of Economic Warfare. In this division there has been set up a staff of experts in various fields whose job it is to go over the submitted material and to judge whether or not it complies with the general rules. If it does, these experts pass it on to the Office of Censorship where the material is once more reviewed. If it again passes the official scrutiny, a license is issued to the publisher and he is permitted to export the material—to send it out to his foreign subscribers.

But suppose the two groups of governmental officials mentioned above do not agree with the editor's selection? Then the license is issued with restrictions: The offending material must be "excised" from all copies that are to be mailed abroad. How to excise it is left up to the publisher's judgment. In the cases with which Scientific American has been specifically concerned, the directive for excision was not received until nearly press time. Thus the decision was made to run the material in those copies intended for domestic consumption and to lift the type and run blank spaces, with the notice mentioned above, in those copies to be sent out of the country. So far this has been done in two issues.

That, in essence, is the mechanics of the only compulsory censorship which has so far been placed on the press of the United States. It concerns only export copies, and therein lies the obvious futility of it all. We have not been reading too many spy stories or seeing too many movies when we state that it is our belief that every copy of Scientific American and of every other semi-technical and technical publication in the United States is carefully scanned, *in this country,* by foreign agents. This they do regularly, regardless of whether or not a single copy of a single informative publication is ever placed in the foreign mails by its publisher.

We are not alone in our opinion regarding the efficiency of the enemies' information collection systems. We have talked to many men directly concerned with the problems of censorship and, almost without exception, they agree that technical information originating in the United States could possibly reach enemy hands long before it could ever get there as a result of copies of magazines being mailed to foreign addresses. (The reader should bear in mind of course, that no magazines can be transmitted to enemy countries, to enemy occupied or controlled territory, or even to certain countries contiguous to enemy nations.)

Yet these men of the Board of Economic Warfare are carrying on faithfully in a thankless job. They are constantly at swords' points with publishers; they are always open to the suspicion that they are playing favorites. Yet they discharge their duties as they see them. Although they are the men who "make holes" in our copies intended for export, we have the greatest of respect and the greatest of sympathy for them in an unenviable position.

Our only hope is that someday there will come a complete realization of the futility of the present export censorship and that these technicians who now spend their days poring over page proofs will be released from this tedious process, to turn their technical talents to more fruitful fields of endeavor.—*A.P.P.*

WHERE STAND THE VITAMINS?

Where do vitamins stand today in sound, conservative scientific and medical circles?

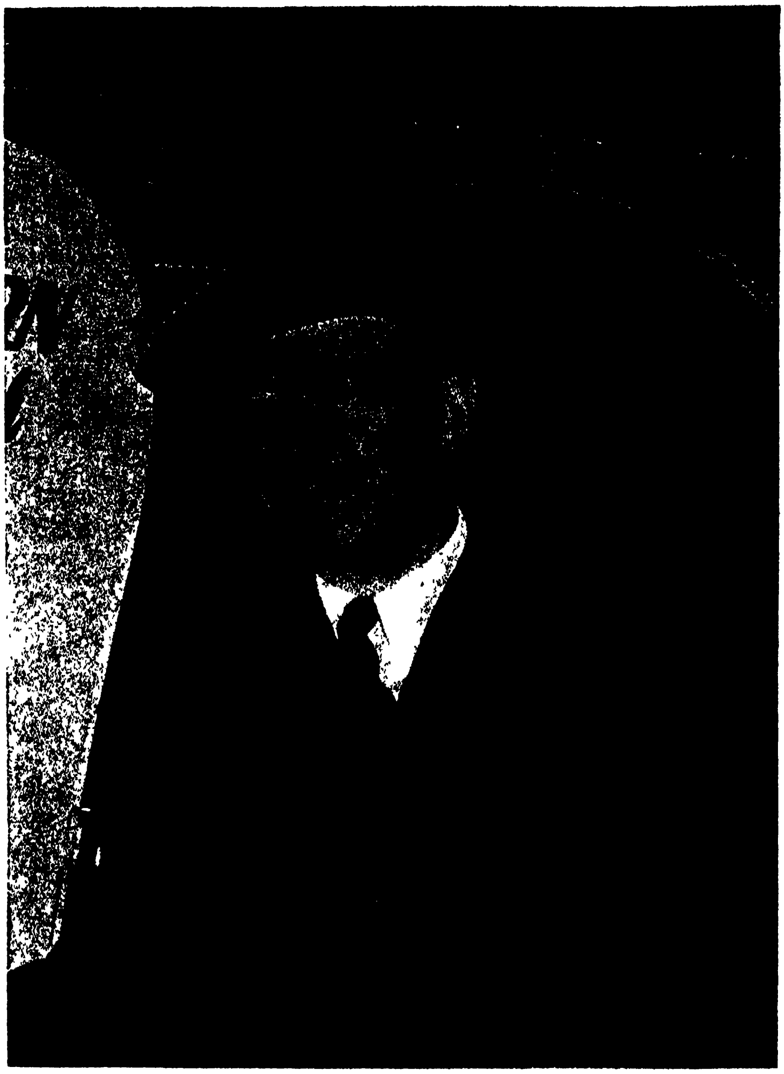
Now and then the American Medical Association issues official reports in which subjects—some of them not necessarily brand new—are weighed and sifted just as if they were new. That is, detachedly. A recent report of the Association's Councils on Pharmacy and Chemistry and on Foods and Nutrition thus deals with the vitamin mixtures available in prepared form—capsules or tablets.

First, the Councils find that prolonged deprivation of vitamins does produce a variety of diseases. Advice to the physician dwells on treating these diseases first with a food diet rich in vitamins, but does not condemn or even look askance at supplementing the diet with appropriate vitamin preparations.

Still unremedied, the Councils find, is the fact that some of the vitamin mixtures are badly balanced—enormous doses of Vitamins A and D and relatively insignificant amounts of riboflavin (B_2). For the adult, the minimum daily requirement of vitamins it recommends is: Vitamin A 4000 U. S. P. units; B_1, 1 mg.; riboflavin, 2 mg.; C, 30 mg. D, 400 U. S. P. units. It also asks for more informative labeling and for restrictions of advertising claims.

These are total vitamin intake requirements. If the layman who is not under a doctor's care can obtain all of these direct from his diet, we shall not become a nation of pill gulpers.—*A.G I.*

Personalities in Industry



EDGAR STALEY GORRELL

By the time he was 21 years old Edgar Staley Gorrell had accumulated a diploma from Baltimore City College, a B.Sc. and a lieutenancy from West Point, and an insatiable desire to learn all there was to know about aviation. During the next eight years of his extremely active life, the young officer not only satisfied his appetite for knowledge of flying, but he also acquired an M.Sc. from Massachusetts Institute of Technology, a colonel's commission in the Army, the Mexican Punitive Expedition medal, the British D.S.O., the French Legion of Honor, and the Victory and Distinguished Service medals from his own country.

These awards are readily understandable when it is known that after two years in the infantry, the youthful lieutenant transferred to the Aviation Section, Signal Corps (now the Army Air Corps) as early as 1914, went with Pershing into Mexico, and was sent to Europe in 1917 as a member of the Bolling Commission to help determine what aerial material should be produced in the United States and what produced abroad. From that start he moved to Chief Engineer Officer of Air Service of the A.E.F., and in the course of serving on all five fronts he became successively Assistant Chief of Staff and Chief of Staff of our expeditionary air forces.

In 1920, at the ripe old age of 29, he resigned from the Army with the rank of Colonel, and for the next 15 years the automotive industry claimed his close attention. However, in 1936 the scheduled airlines agreed that their industry needed as a "czar" a man with practical flying experience, executive and diplomatic ability, scientific background, and general knowledge of aviation. Colonel Gorrell was chosen for this position and became president of the newly organized Air Transport Association of America.

Since then the head of the Air Transport Association has been a busy man. He averages 100,000 miles a year on the airlines, writes one or more dynamic pamphlets or speeches a week. When he is in his Chicago office—and that has totaled as little as 65 days out of a year—his rapid-fire dictation keeps two, sometimes three stenographers well occupied. His is a powerful, constructive force in public relations, and his absolute fetish toward safety and accuracy has been successfully transmitted to every member of the industry, as attested by the records.

Now past the half-century mark, whatever the Colonel does, he still does with all his might, be it work, swimming, collecting odd bits of Lake Michigan driftwood, or gardening at his home in Lake Forest, Illinois. In the latter, Mrs. Gorrell, who is an aviator in her own right, joins in keen competition. There is a third Gorrell 11-year old Peter, whose laudable ambition is to emulate his Dad, and who is the pride of the Colonel's little "regiment."

Probably the achievement of which he is most proud was his membership on the Army Air Service Investigating Committee of 1934, for it was from the deliberations of that body that the G.H.I. Air Force was created (the Colonel's idea), and from which much of a constructive nature with respect to military aviation has been accomplished. Add to this the fact that Colonel Gorrell's views and comments since his association with the Air Transport Association have contributed much to the background for legislative and administrative action in civil flying, and it is easy to see why he has been termed the "spark-plug" of our civil aviation industry.

98TH YEAR **SCIENTIFIC AMERICAN** DECEMBER 1942

NAVY SKY-FIGHTERS

Aircraft of the United States Navy

WALTON L. ROBINSON

Modern naval warfare is three-dimensional; gone forever are the days when sea fighting was restricted to encounters between surface ships. The navies of today fight on the sea, in the air above, and in the waters beneath. Relative strength can no longer be calculated by the simple process of totaling tons and guns; new weapons—the mine, the torpedo, the submarine, and the airplane — have made their appearance, adding many complex and unpredictable factors to the art of sea warfare.

Latest of these weapons is the airplane, an American invention which appeared just after the turn of the century. A few years later in World War I, planes were employed with some effect in the military operations, but they had little influence on the war at sea. It was not until the years immediately following the 1914-18 conflict that the possibilities of naval aviation began to be fully realized, and then only by the most rabid air enthusiasts. Like most pleaders for some special weapon, however, they overstated the case for the plane, blandly declaring that it had made battleships obsolete and would even abolish navies altogether. Actually, the plane has done nothing of the sort, but it has quite definitely established itself as another and absolutely essential weapon of naval warfare.

The United States Navy was one of the first to recognize the potential value of aircraft and today possesses what is generally conceded to be the finest air service of its kind in the world. Our naval planes are as good as or better than those of any other nation, while the training and morale of our fliers are unsurpassed. This very satisfactory state of affairs is no matter of luck; rather, it is the result of a long and painstaking development which really began in July, 1921, with the creation by Congress of the Navy's Bureau of Aeronautics. Rear Admiral William A. Moffett was the first Chief of this bureau; he remained in office until his untimely death April 4, 1933, in the crash of the rigid airship *Akron*. Under his direction our naval air arm developed rapidly and established many speed and altitude records. Three aircraft carriers were also commissioned—the old *Langley*, formerly a navy collier, and the *Lexington* and *Saratoga*, converted during construction from their original battle cruiser design. The U.S.S. *Ranger*, our first ship laid down as an aircraft carrier, was launched a few weeks before Admiral Moffett's death.

● **Following the series of five analytical articles on battleships, aircraft carriers, cruisers, destroyers, and submarines of the United States Navy is this clear and concise description of our naval aircraft. We propose to follow these six inter-related Navy features with a comprehensive article on the tactical usage of each branch of our naval fighting forces, as soon as it is approved for publication by the proper authorities. The previous articles appeared in our issues for May, August, September, October, and November of this year.—*The Editor.*** ●

The various types of planes used by the Navy are officially designated by a system of letters and numerals. An initial letter or letters indicate the function or class of the plane; a following numeral, if present, indicates the model; and a final letter, the manufacturer. Following this group and set off by a dash is a numeral indicating the series or modifications of the model. Thus the designation PBY-1 indicates that the plane is a P (Patrol) B (Bomber) Y (Consolidated) -1 (First model). Any minor alterations to this basic design, such as slight changes in structure or armament, would make the new model a PBY-2. An entirely new patrol-bomber model built by the same manufacturer would, on the other hand, be designated a PB2Y-1. A modification of this model would be a PB2Y-2.

The letter "X" preceding a designation indicates that the model is experimental. This "X" is discarded when the plane goes into production. The letter "V," indicating "heavier-than-air" craft (as distinct from "Z," employed to designate "lighter-than-air" craft—blimps and rigid airships), is placed before the functional letter or letters when referring to classes of planes or abbreviating the names of air squadrons, but is omitted from the designations of individual models, as in the examples given above. Thus patrol-bombers in general are spoken of as VPB's, while "Patrol Squadron Eleven," for example, is rendered VP-11, the second functional name and its corresponding letter being dropped.

On October 1, 1941, two months before Pearl Harbor, the United States Navy had on hand a grand total of 4862 aircraft An additional 5832 planes were on order under the Expansion Acts of 1940-41, which had authorized a strength of 16,000 aircraft. This total was subsequently increased to 27,000 planes, while the Emergency War Program, which followed our entry into hostilities, provided for some 60,000 naval aircraft of all types. Only combatant aircraft—fighting, scouting, bombing, torpedo, observation, and patrol planes—will be discussed, however, as they are the ones which exercise a direct influence on and actively participate in naval operations.

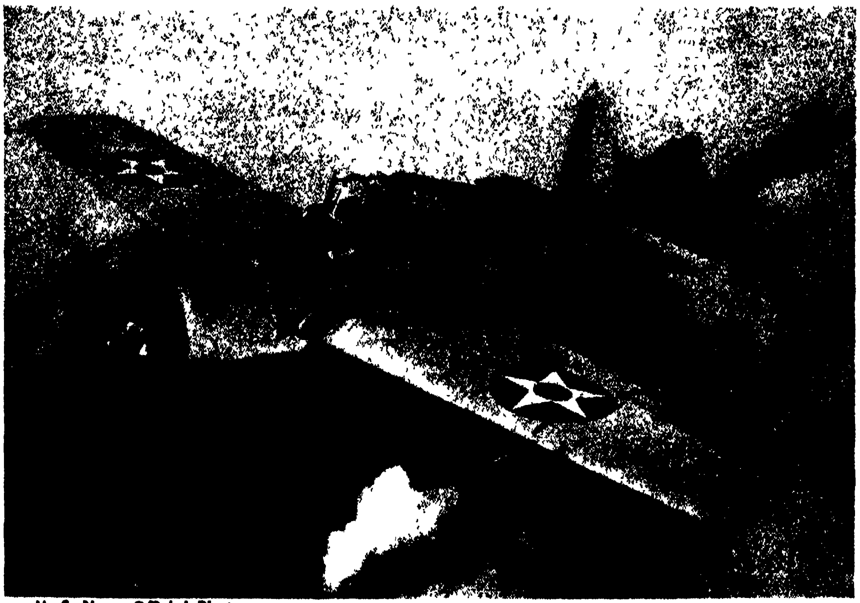
These aircraft are of three very distinct types: landplanes, which operate from aircraft carriers or land bases; seaplanes, which are carried by battleships and cruisers, being flown off from them by means of catapults; and flying boats, operating from coastal bases, advanced shore bases, or tenders. Carrier-based aircraft are the fighting (VF), scout-bombing (VSB), and torpedo-bombing (VTB) planes. Seaplanes are mostly of the scout-observation (VSO and VOS) type, while the big flying boats are all of the patrol-bomber (VPB) type.

The VF's, or fighting planes, are the Navy's smallest and speediest combatant aircraft. These single-seaters have two distinct missions, one defensive and the other offensive. Their primary mission is defensive: to secure control of the air above combat areas and to protect friendly planes and ships by destroying hostile fighters, bombers, torpedo planes, and other aircraft. Their secondary and offensive duties consist of attacking enemy surface warships, submarines, shore installations, and their exposed personnel with machine-gun fire, small cannon, and light bombs.

Our fighting planes in service are the products of three well-known aircraft manufacturers: the Brewster Aeronautical Corporation, the Grumman Aircraft Engineering Corporation, and the United Aircraft Corporation. Their respective identification letters are A, F, and U. All of the Navy's fighting planes, as well as most of its other combatant aircraft, are powered by either Pratt & Whitney or Wright radial air-cooled engines developing from 450 to 2000 horsepower on the take-off. A few scout-observation models, however, have a Ranger in-line air-cooled engine.

During 1937-40 three improved models of the Grumman F2F-1 biplane, the F3F-1, F3F-2, and F3F-3 entered service. The F3F-2 and F3F-3 models, fastest of the group, have a top speed of only 270 miles per hour. The last two-winged fighters built for the Navy, all of these planes are now obsolete and mostly employed as combat trainers.

In 1940 Grumman delivered its first monoplane fighter—the twin-engined experimental Skyrocket or XF5F-1, which is powered by two 1200-horsepower Wright Cyclone engines. The greatest secrecy surrounds this plane, but it is known to be in the 400 miles per hour class. The Navy has not announced production contracts for the model, which, as a result of exhaustive tests, is believed to be undergoing considerable modification.



U. S. Navy Official Photo

Grumman Wildcat Fighter (XF4F-3) above the clouds

Other fighters delivered in 1940 were the Brewster F2A-1's or Buffaloes. Powered by a 950-horsepower Wright, they have a top speed of 330 miles per hour and a cruising range of 1000 miles. Forty-two of them were released to Finland in 1940, being replaced by an equal number of improved F2A-2's.

In 1941 Grumman delivered its F4F-3's and F4F-3A's (Wildcats), while Brewster completed its F2A-2's and F2A-3's (Buffaloes). The Wildcats are powered by a 1200-horsepower Pratt & Whitney Twin-Wasp engine for a top speed of about 350 miles per hour. They have a cruising range of about 1150 miles and a service ceiling of 28,000 feet Their equipment includes bullet-proof gas tanks and armor protection for the pilot.

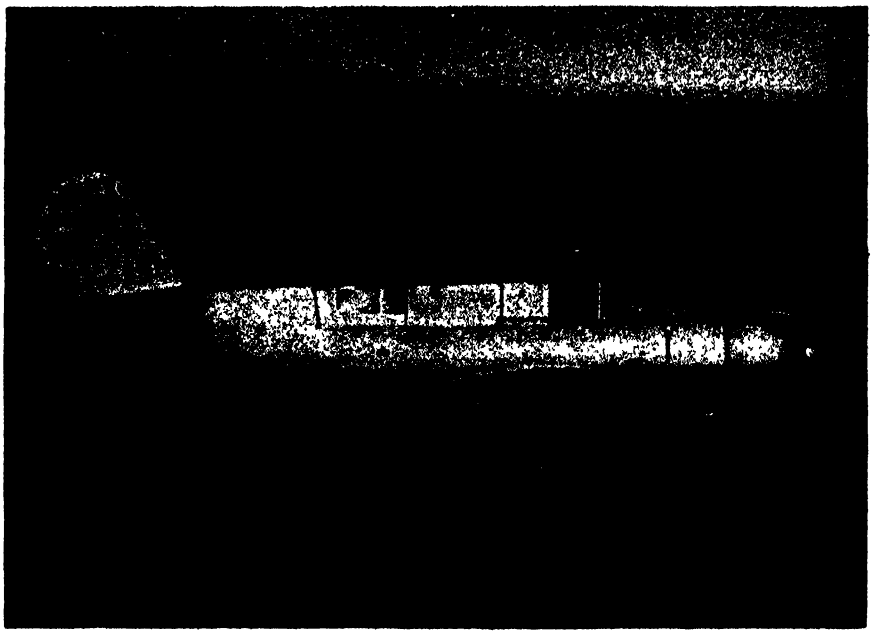
The Buffaloes have a 1200-horsepower Wright engine for a miximum speed of 360 miles per hour They are credited with a range of over 1400 miles and a 30,000-foot ceiling. Armament comprises four .50-caliber machine guns and two 100-pound bombs. The F2A-3's are generally similar to the F2A-2's except for their folding wings. Several hundred of them were supplied to Britain and the Netherland East Indies during 1940-41.

Latest Navy fighters, delivered this year, are Grumman's F4F-4's and F4F-4B's and the Vought-Sikorsky (United) F4U-1's. All data regarding the new Wildcats are restricted, but some details of the F4U-1's (Corsairs) have been released. These planes, specially designed for carrier use, have an 18-cylinder Pratt & Whitney Double-Wasp engine rated at 2000 horsepower on the take-off and giving a top speed of around 400 m p.h. at 35,000 feet. They are generally considered to be the Navy's best fighting planes, particularly for high altitude work.

Scout-bombing planes (VSB's) are the most numerous carrier-based type As their designation implies, these two-seaters are intended for either scouting or bombing duties. As scouts they carry additional fuel in auxiliary tanks hung from their bomb racks, while as bombers some of them can carry a ton of high explosives. In recent years the VSB's have been built by Brewster, Vought-Sikorsky, the Curtiss-Wright Corporation, the Douglas Aircraft Company, Incorporated, and the Naval Aircraft Factory. Identification letters of the last three builders are C, D, and N respectively.

In 1938 Chance-Vought completed a number of monoplane scout-bombers —the SB2U-1's. Two more series of the model, the SB2U-2 and SB2U-3, were delivered in 1939-41. Named Vindicators, all three groups are powered by an 825-horsepower Pratt & Whitney Twin-Wasp Junior giving a speed of 257 miles per hour. Their cruising range is 700 miles. Further details have not been released for publication.

In 1938-39 Curtiss delivered two series of biplanes—the SBC-3's and SBC-4's. The former have a maximum speed of 220 miles per hour, while the latter can do 235 miles per hour. Both groups are now obsolete and mainly employed for combat training. The newest Curtiss scout-bombers and the best the Navy has, are the



U. S. Navy Official Photo
Curtiss Helldiver diver bomber (XSB2C-1) in flight

SB2C-1's (Helldivers), very fast and heavily armed monoplanes specially designed for dive-bombing attacks. Few details concerning them have been released, but it is understood that they are powered by a 1750-horsepower Wright Double Row 14-cylinder engine giving a speed in excess of 300 miles per hour. They are equipped with internal bomb stowage.

Four series of Douglas Dauntless scout-bombers (SBD-1, -2, -3, and 3A) were delivered in 1941. All of them are monoplanes of very similar design. Powered by a 950-horsepower Wright, they have a top speed of 260 miles per hour and a cruising range of about 1000 miles. Their armament includes two .50-caliber machine guns and several 500-pound bombs.

The Naval Aircraft Factory also completed a number of VSB's during 1941. Designated the SBN-1's, they are generally similar to the old Brewster SBA-1's, now out of service. Their maximum speed is 285 miles per hour. Although built and classed as scout-bombers, they have served on occasions as carried-based VTB's (torpedo-bombers).

The only Brewster scout-bombers at present in service are the SB2A-1 Buccaneers, the first of which were delivered this year. As in the case of the latest Curtiss VSB's, details concerning the Buccaneers are restricted. It is believed, however, that they have very similar characteristics to the Helldivers.

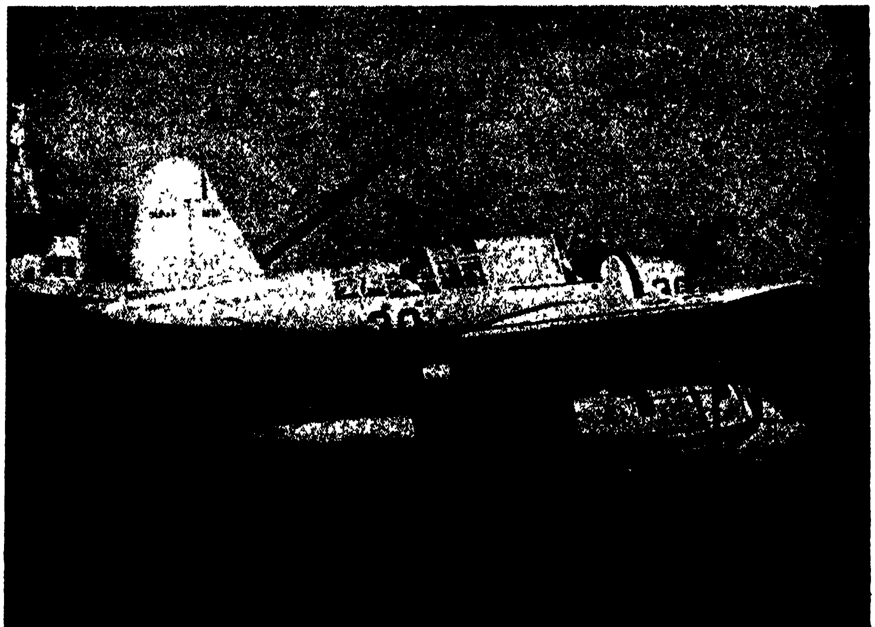
Some of the Navy's older bombing planes, designed primarily for dive-bombing attacks, are classed simply as VB's (bombers). In recent years these planes have gradually merged into the scout-bomber type described above. Torpedo-bombing planes (VTB's) are the Navy's heaviest carrier-borne aircraft and probably its most effective weapon for striking heavy aerial blows at the enemy's large naval units. Whenever possible, they make their torpedo attacks from low altitudes and close to the target. On bombing missions they remain at high altitude and drop armor-piercing or demolition bombs on warships and shore objectives.

The Douglas TBD-1's (Devastators), the first of which entered service in 1938, are three-seat monoplanes with an 850-horsepower Pratt & Whitney Engine. Their top speed is 225 miles per hour and their cruising range 1000 miles. They can carry either a torpedo or a ton of bombs.

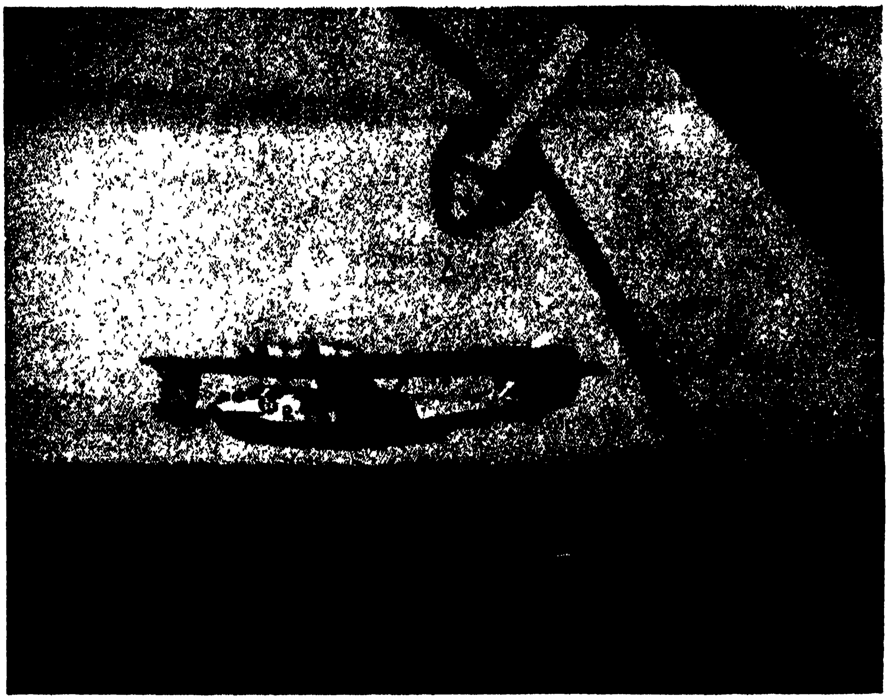
Newest torpedo-bombers are the Grumman TBF-1's (Avengers) which have a speed of 270 miles per hour, a cruising range of 1400 miles and a ceiling of 20,000 feet. They dealt the Japanese Navy some very hard blows at Midway.

Scout-observation planes are officially divided into two types: VSO and VOS. When ship-based, both types are fitted with landing floats but these can be quickly replaced by wheel gear when desired. The VSO's are primarily scouts, operate from cruisers, and have folding wings to facilitate their stowage in hangars aboard ship. The VOS planes have rigid wings and are carried by battleships, whose gunfire they observe or "spot," thereby increasing both the accuracy and range of the big guns. All of our battleships carry three VOS (observation) planes, while most of our cruisers accommodate four to six VSO (scouting) planes.

Curtiss, Vought-Sikorsky, and the Naval Aircraft Factory are the builders of our VSO-VOS planes at present in service. In 1937-39 Curtiss delivered three scout-observation models SOC-1, -2 and -3. A fourth model SOC-4, was delivered to the Coast Guard. Biplanes with a speed of about 165 miles per hour, they are now obsolete. Latest Curtiss scout-observa



U. S. Navy Official Photo
Vought-Sikorsky training ship (OS2U-1) about to take off



U. S. Navy Official Photo
Consolidated Catalina (PBY-2) patrols the coast

tion plane is the SO3C-1 (Seagull), a two-seat monoplane powered by a 520-horsepower Ranger inverted Vee air-cooled engine giving a top speed of 200 miles per hour.

Vought-Sikorsky recently delivered three VOS models: the OS2U-1 and OS2U-2 in 1941, and the OS2U-3 this year. These planes, known as Kingfishers, have a 450-horsepower Pratt & Whitney Wasp-Junior engine giving them a 200 miles per hour speed. They are the Navy's standard observation planes.

The Naval Aircraft Factory in 1940 completed a VSO model, the SON-1, and this year delivered its OS2N-1 observation plane. The former, a low speed biplane, is now obsolete. The latter, however, is practically a duplicate of the Vought-Sikorsky Kingfishers described above.

Patrol-bombing planes (VPB's) are the largest aircraft in the naval service. Known as the "Eyes of the Fleet," their primary mission is long-range reconnaissance from shore bases or aircraft tenders and the protection of convoys from submarine attack. Their secondary mission is to operate against enemy ships or shore establishments, in which case they carry bombs, torpedoes, or mines instead of maximum fuel load. Fitted with bunks and cooking facilities, they can operate for extended periods from small tenders or advanced bases. All of them are flying boats and some have reversible-pitch propellers for maneuvering afloat.

Most of our patrol-bombers have been built by the Consolidated Aircraft Corporation and the Glenn L. Martin Company. The former's PBY-1 Catalina monoplanes date from 1937. Weighing nearly 14 tons, they are powered by two Pratt & Whitney 1050-horsepower engines for a speed of 200 miles per hour. Their cuising range is about 4000 miles and their ceiling 25,000 feet. They can carry two torpedoes or two tons of bombs and require a crew of seven. Four improved series, the PBY-2 through PBY-5, were delivered during 1938-41. The last two models weigh 15 tons and have 1200-horsepower engines. This year a number of PBY-5A amphibians, designed to alight on land or in the water, were delivered.

In 1938 Consolidated completed its first four-engined plane, the XPB2Y-1. After exhaustive tests, this experimental type passed into production as the PB2Y-2. First delivered last year, these giant Coronado aircraft weigh 30 tons, are powered by four 1200-horsepower Pratt & Whitneys, and have a range of some 5000 miles. They carry six or more tons of bombs and a crew of nine.

The Martin company delivered its first patrol-bombers in 1941. These planes, the PBM-1's (Mariners), weigh 20 tons and have a pair of Wright Cyclone 1200-horsepower engines for a speed of 225 miles per hour. A crew of seven and two 21-inch torpedoes or several tons of bombs are carried.

This year Martin completed the huge Mars or XPB2M-1, a 70-ton patrol-bomber with four 2000-horsepower 18-cylinder Wright Duplex Cyclone engines. This great flying boat has a range of over 7000 miles, requires a crew of 11, and can carry four torpedoes or a very heavy bomb load As a transport she can accommodate 150 fully equipped soldiers Some observers regard the Mars which is still very much in the experimental stage, as ideally fitted for the regular bombing of Japan.

These, then, are our Navy's combatant aircraft in service or in production. Upon them we must depend for some time to come. New and greatly improved models will doubtlessly appear in due course, but for the present such excellent aircraft as the Wildcat and Corsair fighters, the Helldiver and Buccaneer scout-bombers, the Devastator and Avenger torpedo-bombers, the Seagull and Kingfisher scout-observation planes, and the Catalina, Coronado, and Mariner patrol-bombers must form the backbone of our hard-hitting Naval Aviation.

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HIGH-OUTPUT ENGINE

Liquid-Cooled, For Use by Navy

In an announcement foretelling a revolutionary change in naval aircraft design, the Navy disclosed recently the development of a huge new liquid-cooled aviation engine approaching 2000 horsepower.

If the Navy's use of this extraordinary powerplant, developed by the Lycoming Division of The Aviation Corporation, follows the same general line of airplane construction adopted by the Army with liquid-cooled engines, then a new series of naval fighter craft, faster and more powerful than any now on first-line duty, is in the making.

Official silence cloaks both the performance figures and future uses of the new engine The formal announcement that it had been completed and placed on contract described it only as "considerably larger than any other liquid-cooled aircraft engine now in production," with power sufficiently great "as to compare favorably with that of the largest type aircraft engine presently in use."

The largest known air-cooled aircraft engines now used by the Navy are the 2000-horsepower units on the giant flying boat *Mars*.

A Chemist Looks At Research

Development Cost Comparisons Reveal the General Value of Research for Many and Varied Industries

EUGENE AYRES
Staff Chemist of the Gulf Research and Development Company

It is a curious circumstance that research, which is the most scientific of all pursuits, should be one of the most difficult to evaluate in dollars and cents. Those of us who are enthusiastic about research are apt to refer to its value in most general terms. We say it is valuable because of this and because of that—all abstract qualities—much as we would define the value of honesty as a business asset.

Lord Kelvin is often quoted as saying that "when you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be." Perhaps Lord Kelvin would say that, despite the eminently scientific nature of research, its appraisal for business purposes is only dimly understood.

It is natural that no generalizations can be made concerning the monetary value of research carried out by an individual. There are notorious cases of extraordinary returns from very little in research, and other more familiar cases in which research has continued year after year without tangible return. But in organized industrial research, the element of chance is less important for several obvious reasons, among which are the number and variety of technical viewpoints and, particularly, the character of the research problems. In general, there are two kinds of research problems On the one hand there are problems that are fruitful only if we are fortunate enough or clever enough to get a particular kind of answer, and, on the other hand, there are research problems which are fruitful without regard to the answer.

Suppose we have reason to believe that a certain organic compound might have useful properties as an antioxidant. We do a lot of work to find out how to prepare this organic compound and then we test it to see if it has the desired antioxidant quality. If the answer is "yes," we may balance the cost of research work on this problem against the value of the antioxidant, but if the answer is "no," we may have no economic justification for this research expense. Here the value of the research depends upon the kind of result obtained. But suppose we undertake to determine the optimum conditions for a process in order that we may know how to design a commercial plant. Here the result has the same value regardless of the conditions which are found to be optimum. A considerable proportion of industrial research is concerned with this second type of problem, and from the voluminous experience of research laboratories in many industries, certain numerical criteria are beginning to emerge.

The author

It is probable that no two research laboratories would agree in detail on the average relationship between the different elements of cost of development, but they would probably not be very far apart. These cost relationships have been formulated by economic studies of many different sorts. For example, a company found it necessary to go into the manufacture of a new chemical in a hurry. There were no large-scale precedents for this operation but two good process ideas were offered by the Research Department. Because of the emergency, it was decided to commercialize one idea without any research, while the second idea was carried in orderly fashion through laboratory and pilot plant. Despite the delay occasioned by months of research, the second idea resulted in a smoothly operating plant before the first and at much lower development cost. The first idea was then sent back to the Research Laboratory and a year later superseded the second.

In another case, illustrating another way of going about it, a new process was commercialized from laboratory data without pilot plant research. A few years later a new plant of the same size was designed and built from data secured from the first plant.

From these and dozens of other cases, it is possible to come to some general numerical conclusions which, being averages, apply to no specific case with any accuracy, but which may apportion development costs in the correct order of magnitude for a majority of industries and companies. Here are three generalized cases:

	Units of Cost		
1. Laboratory Research	1	1	0
2. Patent Prosecution	1	1	0
3. Pilot Plant Research	5	0	0
4. Excess Design and Construction	5	15	20
5. Getting Process in Operation	25	50	65
Total Development Cost	37	67	85

"Getting Process in Operation" is the part of development cost that comes after the commercial plant is built There are some companies which always figure this cost because it is the largest element of development expense and because it affords one of the best measures of technical management. But some other companies permit this cost to be absorbed in operating expense and do not worry about it. This cost may be figured in many different ways but perhaps most conveniently by subtracting the operating profit for the first year of operation from the operating profit for the second year of operation, making indicated adjustments for proper comparison and including, of course, such items as structural changes and losses of materials.

"Excess Design and Construction"

A paper presented before the Division of Industrial and Engineering Chemistry at a meeting of the American Chemical Society.

cannot be figured so easily, but can be estimated by competent engineers. *Total* design and construction cost cannot be regarded as development expense because thoroughly commercialized plants also must be designed and built. But, because of technical uncertainties, it always costs more to design and to build a new process than an old one, and the difference is development expense. The more we know about a process before we start to build, the smaller this difference and also the smaller the cost of getting the plant into operation.

Every authorization for plant construction covers not only investment but also a proportion for development expense; but this proportion cannot be ear-marked as such for the very good reason that it cannot be predicted in advance

The first column expresses the relationship between cost elements which perhaps may be regarded as ideal and, therefore, as showing a minimum total for the average research project Laboratory research and patent prosecution are indicated as of the same order of magnitude Pilot plant expense is five times as high as laboratory expense "Excess Design and Construction" is made equal to pilot plant expense because experience indicates that this is about as low as competent research can bring it and "Getting Process in Operation" is five times as great for the same reason

The most significant comparison is between the columns. Without any research, the total development cost is about 2.3 times the total cost with adequate research Laboratory research without pilot plant work figures 1 8 times the ideal

It is interesting to apply these ratios to special cases. For example, a chemical company, during a certain period, spent on the average about $3,000,000 per year for process development During that period this company did no laboratory or pilot plant research on these processes. The $3,000,000 was made up of "Excess Design and Construction" and "Getting Process in Operation." According to the table, if this company had done $175,000 of pilot plant work per annum, it could have reduced the total development expense for these processes from $3,000,000 to $1,300,000 per annum This would have meant a saving of $1,700,000, or nearly 1000 percent profit from research investment.

This conclusion may well be absurd. The table can be very wrong in specific cases but, on the other hand, it can be wrong in either direction. The conclusion noted may very well be correct.

Regardless of accuracy of application, the generalized figures point toward some interesting conclusions:

(1) Patent prosecution and laboratory research are almost negligible portions of total development expense

(2) Total research, including adequate pilot plant work under the most favorable conditions, figures around one-fifth of total development expense.

(3) The minimum development expense is associated with adequate research expenditures.

(4) Research is about the most profitable investment that can be made

The question is sometimes raised. Can we avoid development expense by the installation of processes developed by others? The answer to this question is clear. We can avoid the small parts of development expense, but we usually cannot avoid the large ones. Many cases can be pointed out in which a company has had lower development expense on processes purchased from others, but there are many other cases in which the development expense has been actually greater. Unless a process has already been thoroughly commercialized, whether a purchased process costs more or less than an independently developed process depends primarily upon the quality of the pilot plant work Certain purchased processes have cost a chemical company far more for development than if they had passed through the company's own laboratory and pilot plant because the preliminary work that had been done by others failed to provide sufficient data for economical design and construction. In general, the only cases in which we can avoid the major part of the normal development expense of new processes are those in which processes have been operated for a sufficient time to iron out all the kinks. But in such cases processes are likely to become obsolete about the time we get them into operation

Technical obsolescence must be regarded as of the utmost importance in the present argument If we pay a million dollars as paid-up royalties for a certain process, this may not seem to be a serious expense if we can assume that this process will not become obsolete. But this is frequently not the case. By the time we get this process in operation, it will be somewhat obsolete, and by the time we install its successor and get it into operation this also is likely to be obsolete Paid-up royalties cannot be regarded as nonrecurring expenses because technical obsolescence sees to it that such expenses recur with dismal regularity.

It appears that process research should be justified (1) by its saving of many times its cost by the reduction of the other greater development costs, and (2) by its effect upon the vital element of timing. Either one of these reasons is sufficient in itself and it is unnecessary to include the reason that research may enable us to charge royalties or to be immune from paying royalties. This last factor has to do not with the justification of research, but rather with the justification of patent prosecution. There is no reason to compare the cost of research with the cost of royalties The comparison should be made between the cost of patent prosecution and the amount of royalties received plus the amount of royalties which otherwise we would have to pay.

Royalties are normally set as high as the traffic will bear. The only reason royalties in general in the chemical industries are moderate is because competitive research has prevented any company from securing a monopoly on any important process This makes the royalties themselves competitive and the company with the strongest patent position will either receive royalties or, if it does not wish to follow the necessary procedure for securing licensees, it will at least pay the minimum royalties. The royalties never seem very large when they are figured on a unit of material, but our competitive disadvantage is measured not by the amount of royalties, but by double this amount, for while we are paying the royalties, the other company is receiving them.

The royalties paid by companies who do little research are small compared with the cost of research that would have been required to provide immunity or to balance royalties paid with royalties received, but large compared with the cost of prosecution of patents to accomplish this result. Failure to protect inventions with patents means not the saving of patent prosecution expense, but the loss of many times this amount of money.

Companies differ widely in their patent policies. One company may not be concerned with the licensing of inventions to others for royalties, whereas another company may do this sort of thing on a large scale. The less aggressive company can defend itself only with patents, and its patent position must be made stronger than that of its more aggressive competitor. This is merely another way of saying that its technical position must be stronger than that of its competitor; for patents are, after all, merely inexpensive handles with which to wield the technical weapons effectively.

Under some circumstances, product patents can be even more important than process patents. It happens that most product patents in the chemical industries now refer to relatively small volume products, but there are some important exceptions Here again research is justified, not by immunity, but by getting products on the market before instead of after our competitors. If we grant that research expense can be justified in this way, it is proper to balance against royalties only the expense of patent prosecution.

Product patents are of more value to the company with the less aggressive patent policy than to the company with the more aggressive patent policy because it takes more good patents to defend than to attack. Furthermore, there are more offensive patent alliances than there are defensive ones.

The evaluation of research in accordance with the foregoing principles requires a certain measure of optimism, but this is, after all, the same sort of optimism that inspires a company owner to believe that his company can survive as a business enterprise. For only through successful research is ultimate survival possible.

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New Glass For Precision Optics

Compacted Glass, Made by a Secret Process, Makes Possible New Accuracy in Lens Manufacture

THROUGH the development of a new, scientifically controlled process of heat-treating optical glass, mass production of precision lenses—the "glass eyes" of microscopes, projectors, and other optical instruments—is now possible, according to Dr. E. D. Tillyer, research director of the American Optical Company.

The new technique, Dr. Tillyer declares, is significant because it eliminates production delays and many of the rejections which were previously encountered in manufacturing complex prisms and precision lens systems for which there is an urgent military demand. The process, he states, produces compacted glass — glass at maximum density and with maximum light-bending power—that is perfectly homogeneous throughout its entire structure. This optical uniformity simplifies the mass grinding and polishing of precision optics and prisms because their optical performance can now be made so accurate that re-annealing or hand correcting is unnecessary. The process also stabilizes the glass so that future changes in its performance do not take place as the years roll by.

This stabilized glass, Dr. Tillyer reports, is definitely superior to that made previously, as shown by a precision laboratory test which determines the exact performance of an optical system. The new heat-treating technique is now being used by the optical concern's scientific instrument division, Spencer Lens Company, in the production of military optical instruments.

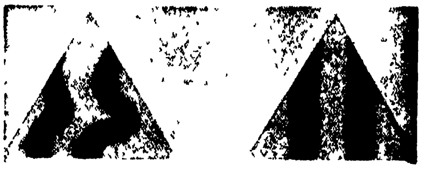
In explaining the process, Dr. Tillyer points out that glass can perform queer tricks. For example, a cut-glass goblet suddenly cracks for no apparent reason. Difficulties are encountered in matching the several glasses used in making bifocal lenses for near and distant seeing. The optical lens systems of precision scientific instruments may lose their accuracy after years of storage because a change of light-bending power (refractive index) takes place

Studying the expansion characteristics of the new compacted glass by means of comparison with a standard alloy

To determine the reason for these imperfections, it was assumed that something was lacking in the glass annealing picture. The commonly accepted practice was to bring glass to a certain temperature range, keep it constant for a specified time and then let it cool slowly. This procedure actually did eliminate mechanical strain—a condition that could be revealed by polarized light.

But in addition to removing strain it was believed that the atomic structure of the glass should also be perfectly packed and perfectly settled during annealing so that the maximum light-bending power would be achieved. Tests showed that there were times when glass was not perfectly packed even when the strain had been eliminated. The production of a glass that was perfectly packed throughout its entirety seemed the answer to the problem.

Accordingly, Dr. Tillyer photographed the behavior of various specially treated sample glasses under heat in comparison with a standard metallic alloy of known thermal expansion. After a study of the film, a graph was plotted that not only showed the range commonly used in ordinary strain annealing, but another point which looked as if it might bear investigation. (The details of this new time-temperature cycle for annealing optical glass are a military secret and cannot be revealed.)



Typically poor glass result, often obtained with old forms of annealing, at left, compared with new glass at right. Lines indicate that refractive index is not constant throughout glass at left

To investigate the new critical point in actual practice, tiny glass specimens were placed in three electrically-heated "thimble" furnaces, so insulated that the temperature could be controlled closely.

Measurements showed that glass maintained at the temperature indicated by the new theory and selected from the graphs reached a maximum index of refraction (light-bending power) higher than that usually reached in the older accepted manner of annealing. The glass seemed to be perfectly packed — completely homogeneous. For comparison, these thoroughly compacted glass specimens were held at temperatures above the new annealing range. These samples lost some of their compactness, and their refractive index was lowered.

Bolstered by this mass of pertinent information, the new annealing process went into actual production. Results were the same. The glass was perfectly homogeneous, as revealed by a prism interferometer test. This means, according to Dr. Tillyer, that the day of "hit or miss" annealing is over—that a regular time and temperature schedule can be set up and followed with the result always as anticipated.

Precision lens systems can accordingly be manufactured without glass production delay and with the certainty that the glass will remain homogeneous permanently

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WORKERS—The number of research workers in the petroleum industry is now about 6000, of which about 45 percent are highly trained scientific men. There are 563 research workers for every 10,000 wage earners in the refining branch of the business, or almost twice the ratio in the chemical industry

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RESEARCH CONTINUES

Machine-Gun Manufacturer Invades Other Fields

When, in 1941, J. Russell Maguire President of the Auto-Ordnance Corporation, manufacturers of the Thompson Submachine Gun (the "Tommy Gun"), realized that there was a definite need for research in other and somewhat allied fields, he did something about it. This realization was the beginning of a systematic effort to assemble a staff of highly competent engineers, chemists, and physicists for the express purpose of conducting research along well defined lines that bear closely on many phases of our war activities.

Less than a year later the rapidly growing research staff was housed in permanent quarters in Connecticut where they are provided with every essential for the research and development work which they are doing in fields directly connected with the total war effort. Some of the endeavors include: improvement of the present submachine gun as well as the development of new types of guns, work on an asphalt process for speedy laying of airport runways and roads under severe conditions; perfection of methods of de-bulking dehydrated foods for economical shipment to distant points; research in the broad field of electronics.

That the manufacturing activities of the Corporation have been eminently successful is evidenced by the Army and Navy "E" Award recently received, of which Mr. Maguire and his staff are justly proud.

MAGNESIUM RECLAIMED

By New Welding Method Using Helium

Much strategic magnesium metal already fabricated but with small defects, now can be quickly and easily restored to usefulness, thanks to a new fusion method of welding which was brought about by the close wartime co-operation of two major American industries. This new method of fusion welding, which takes advantage of the peculiar properties of helium, an inert, non-explosive, non-flammable gas, is the result of joint development by The Dow Chemical Company and Northrop Aircraft, Inc. Of particular interest at this time of rush war production is the fact that vital aircraft sand castings, some of which were formerly discarded because they did not meet standard specifications, now can often be reclaimed by this advanced method.

As magnesium, lightest of all structural metals, is an essential material for the construction of airplanes and other military equipment, the new helium arc method for welding magnesium alloys has an important bearing on our war production progress, according to Dow spokesmen. Its advantages over other methods of joining are the elimination of rivets, ease of operation, and greater speed of production over a wider range of design These results are possible because the electric arc applied to the parent metal is shielded by a blanket of inert helium gas which prevents oxidation of the molten weld metal. Oxygen cannot penetrate the helium "envelope"

SKIN HEATER

Solves Sheet Metal Wrinkle Problem

Heat therapy has moved out of the hospitals and into the aircraft industry through a recent development at The Glenn L. Martin Company. A major difficulty in the riveting of aluminum "skins" over spars and ribs to make wings has always been the unavoidable wrinkling and buckling of the skins under the pounding of riveting hammers The wrinkling and buckling, even though slight, interfere with the smooth flow of air over and under the wing.

In the system of "heat therapy," devised by Harry F. Kniesche, Assistant Factory Manager at the Martin plant the various sheets of aluminum that make up a skin are riveted together on a wood frame that has the shape of the wing. The skin, full now of unavoidable small buckles and wrinkles, is then laid on the wing of the ship The skin heater, which might be described as an oversized version of the electric heating pad which people apply to a sore back, is laid on top of the skin. The heater fits snugly, for it has the exact contour of the wing.

The heat is turned on. In a few minutes the skin has a temperature of 140 degrees, which causes enough expansion to rid it of all wrinkles and buckles. While rheostats hold the temperature constant, the skin is quickly stitch-riveted round the edges and along the ribs. Then the heater is removed and the skin shrinks as taut and unwrinkled as a drum-head.

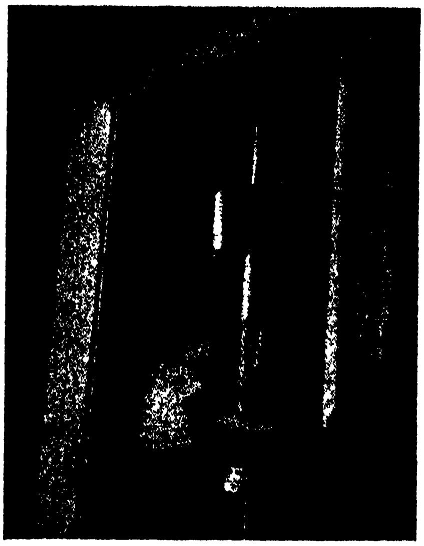
In ridding skins of wrinkles and buckles the "skin heater" has cleared up a troublesome problem of wing construction. At the same time, because it allows a whole skin to go on in one riveting operation, it has helped speed production.

SELFCONTRACTOR

Company Takes Over When Subcontractor Fails

By acting as "subcontractor to itself," the new Westinghouse Merchant Marine Division has slashed nearly a year from the tooling time required for quantity production of 30-ton gears to drive new war cargo ships This situation was brought about by the fact that an over-burdened machine tool builder, although able to design the massive gear-cutting machines, lacked the plant capacity and manpower to finish and assemble them within 12 months of the time Westinghouse needed them. The machine tool builder was asked to send the large parts of the machines to Westinghouse, where they were assembled. As a result, production of ship gears was started nearly a year ahead of the time this would have been possible had not the company undertaken to become subcontractor to themselves

Some of the "bull" gears that will be made on these machines — gears that are coupled directly to a ship's propeller shaft to drive the vessel — are more than 12 feet in diameter Yet each of their 693 teeth must be machined to an accuracy of three ten-thousandths of an inch. This means that the "hobbers" — the machines which rough and finish-cut, or "hob" the gear teeth — must be built to tolerances that are even finer. If even minute errors were allowed in the cutting of these teeth, they would make so much noise under the pressure of thousands of horsepower from the ship's turbines that sound detecting devices on enemy submarines could locate the ship in the dark and from great distances. This gear-cutting is so precise that each gear hobber is enclosed in a special air-conditioned room in which temperature and humidity are rigidly controlled.



Air conditioned for accuracy

WORN-OUT TOOLS

Can be Salvaged and Put Back Into Service

With the huge production of war equipment causing a heavy drain on supplies of metals, automotive companies are greatly accelerating their salvage and conservation activities. For example, the shortage of cutting tools, which is far more serious than most people realize, has led to development of reclaiming methods that in peacetime would be prohibitive in cost.

An ordinary tap, of the type which you once could pick up at the five-and-ten-cent store, now takes two months to replace. It takes six months to get milling cutters today, and to get such a part as a taper reamer for one standard type machine tool requires three-quarters of a year.

Thus, the salvaging of tools now on hand becomes a definitely sound practice, for monetary savings are relatively unimportant, when values are measured in terms of life-and-death as they are in wartime.

A new method of restoring a worn-out forming tool, as a specific example, costs more than it would to replace with a new tool, but through use of such methods, thousands of pounds of cobalt steel are being saved. The worn-out tool which, in normal times, would be ready for discard, is first annealed and forged to restore size and shape. It is then machined, heated, and quenched to produce a new tool to which grinding, the final step, restores polished surfaces.

Along with the reclaiming processes, all plants are urging workers to use great care in handling precious tools. Broken tools are conspicuously displayed with dramatic explanations of the cost of such waste in terms of time and effort.

Time and labor are, of course, the chief values to be considered now, but waste can still be measured in monetary values. In such terms it costs $40 for tools to produce one airplane propeller. And for every airplane engine, which requires from 15 to 20 cutters alone, the tooling cost ranges between $800 and $1200.—*Automotive War Production.*

PIPE LINE

Pipe Protected from Corrosion by Asbestos Wrapping

The new 24-inch war emergency pipe line, now being constructed from Longview, Texas, to Salem, Illinois, is the largest-diameter line carrying crude oil ever built and will establish records, both for size and speed of construction.

Since steel must be conserved by every means possible, this underground line is protected from corrosion by a layer of a special asbestos felt, the wrapping being done speedily and with precision by a machine which first applies a waterproofing coating as the pipe revolves.

ARC WELDING

Looks to a Bright Future

That war industries have only just begun to gain the benefits of modern arc welding is shown by a recently completed industrial study of this method. This study also definitely indicated that further applications of the welding process will eventually slash millions of dollars off the United Nations war bill and will cut by 30 percent the time required to produce ships and planes.

Furthermore, it now appears that arc welding will provide the means for turning out vitally needed naval and military equipment which is more combat-proof than at present; at the same time welding should be able to save an average of three hundred pounds out of every ton of steel now going into war production.

The industrial study of welding, previously mentioned and on which the above statements are based, has been carried on by the James F. Lincoln Arc Welding Foundation. From that organization also comes the prediction that the arc welding process has virtually an unlimited field for further applications. Many industries which have adopted welding in war production will doubtless continue its use after the war, thus broadening the applications of the process in civilian production, according to the Foundation.

AIR CONDITIONING

Reverts to its Original Conception

The action of the War Production Board in asking department stores, theaters, hotels, and office buildings with air-conditioning equipment above 100 horsepower to "volunteer" such equipment for "active duty" in war production factories should serve to eliminate from the public mind the misconception of air conditioning merely as a "comfort" industry, according to Dr. Willis H. Carrier. "It is seldom recognized that air conditioning had its inception in industry as a production tool. Nor is it common knowledge that the greatly expanded production facilities of Carrier Corporation, and others in the field of air conditioning and refrigeration, are today devoted 100 percent to production for war industries," Dr. Carrier says.

"Not only is low temperature refrigeration equipment essential to the production of certain types of synthetic rubber, as pointed out by Donald Nelson in his request that stores and others 'volunteer' their equipment, but air-conditioning equipment serves a myriad of other war production requirements.

"Air conditioning, for example, makes possible a high degree of accuracy where work to close tolerances is called for. Thus, it helps insure the amazing accuracy of bombsights and firing devices. In addition, air conditioning serves in the production of powder, in the loading of shells, in the production and processing of photographic film, in the manufacture of lenses and fine optical instruments and in countless other ways," Dr Carrier points out.

AMMONIA

How This Common Chemical Aids Many Industries

AMMONIA, common to the household for cleaning woodwork, tiles, and windows; to the first-aid kit as a stimulant; and to the ice factory as a refrigerant, is an indispensable war material.

There are at least 2000 industrial uses for this chemical. Ammonia, for instance, is an ingredient basic to the manufacture of explosives for bombs, torpedoes, shells, and cartridges.

It hardens metals for vital parts of airplanes, tanks, and guns. It helps vulcanize important rubber articles. It is used in making nylon. It enters into the manufacture of fertilizers It is employed in one process for the manufacture of "Lucite" methyl methacrylate plastic for the noses, gun turrets, navigation "blisters," and other transparent sections of fighting airplanes.

Synthesized by Du Pont and others from the elements of air and water with the aid of coal, ammonia simply is one part nitrogen—nitrogen is four-fifths of the air we breathe—chemically combined with three parts of hydrogen, a constituent of the water we drink.

Ammonia plus oxygen produces nitric acid. All military or commercial explosives require nitric acid. Furthermore, nitric acid enters into the manufacture of cellulose nitrate plastics, which have many military applications.

Gaseous ammonia flowing across heated steel under proper conditions imparts a hard, wear-resistant surface over the soft core without changing the dimensions of the metal. This process, called "nitriding," is necessary to many metal parts for airplanes, tanks, guns, and ships.

Ammonia helps in refining petroleum products. Crude petroleum contains acids harmful to stills, and these acids are neutralized by the addition of small amounts of ammonia.

The effectiveness of chlorine for destroying bacteria in drinking water is materially increased by the presence of ammonia. This combination reduces the objectionable odor and taste associated with chlorine and has a more prolonged sterilizing action than chlorine alone.

In fertilizers, ammonia is used for the ammoniation of super-phosphate and for the manufacture of urea and of sodium nitrate—synthetic Chile saltpeter.

Synthetic urea, made from ammonia and carbon dioxide, is basic to the manufacture of ammonium sulfamate, the new industrial chemical used for flame-proofing workmen's clothes, uniforms, and other textiles. Urea-formaldehyde plastics have numerous military applications.

Ammonium carbonate, a compound of ammonia, is one of the materials used to form the "bubbles" in sponge rubber. Mixed with the rubber, this chemical decomposes under heat and forms a gas which "blows the bubbles."

Ammonia is used in the manufacture of vat dyes, and in wool scouring to remove fats, waxes, and dirt. Long and varied is the list of achievements of this relatively inconspicuous chemical.

FOUNDRY WORK

Is Important Factor In Nation's War Production

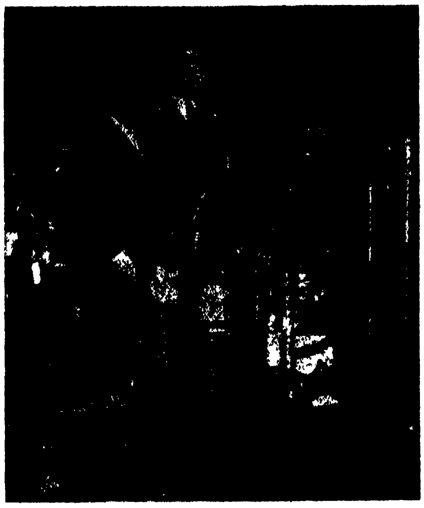
THE art of making moulds and pouring molten metal into them is ages old, so the spotlight is often taken from it by new and spectacular machines when figures for increased efficiency in mass production methods are given out. But during the last decade or two, very few industries have increased their over-all efficiency to such a degree as has the foundry industry.

Mechanization has greatly speeded up almost every foundry operation. Conveyor lines do many laborious jobs of moving moulds and materials. Machines condition and deliver sand to the foundry's moulding stations

Not the least among the contributions to the efficiency of the foundry is the improvement made in moulding machines, according to The Osborn Manufacturing Company, one of the pioneers in their development.

When Osborn built its first moulding machine in 1909, the automobile industry was in its infancy and was soon to demand mass production methods that challenged the ingenuity of engineers. Everything in the foundry was done by hand. Completion of three of four molds for engine blocks was a day's work for a moulder and his helper. The moulders shoveled their sand, tamped the sand around the patterns, rolled over the moulds, drew out the patterns—all by hand This was a tedious process The percentage of scrap was high and castings made under these conditions lacked uniformity.

The moulding machine was revolutionary. Today, on an automotive production line, a pair of these machines can turn out one engine block mould a minute. A tremendous load has been taken off the moulder's back. Using compressed air, and in some cases, electricity, as a source of power, the modern moulding machine rams the sand around the pattern, removes the pattern from the sand and handles the flask—all mechanically. The making of moulds by machinery conserves the human element, and the precision and accuracy of the machine is transmitted to the mould itself. The result is that castings made from such moulds are true to pattern and uniform in weight


One of the newest moulding machines

One of the more difficult jobs demanded of Osborn machines was the moulding of cast aluminum cylinder heads for airplanes. These cylinder heads are cast with the cooling fins as integral parts. The present demand for greater power calls for larger cooling surfaces This means more and deeper fins. Present aeronautical design requires that the heads be moulded with the fins spaced five to the inch, and that many of them be 3½ to 4 inches deep. Those familiar with foundry practice will immediately recognize the difficulties in producing moulds so delicate, at the high working speed required

The process of drawing the pattern from the sand without distorting the thin walls of sand between the fins called for a moulding machine built to an accuracy of a thousandth of an inch.

This demand was met, and now large numbers of a specially designed, precision-built moulding machine are being supplied with working parts hardened and ground. These machines are capable of operating with less than one thousandth of an inch variation in the pattern draw stroke.

In addition to the cylinder heads, the modern moulding machines are playing an important role in making possible the mass production of many other precision parts, parts which meet the rigid inspection requirements necessary to qualify for a place in the finest airplanes built in the world today.

RESISTANCE WELDING

Machine Controlled by the Weld Itself

An entirely new approach to resistance welding is made in the "Temp-A-Trol" forge welder, which makes possible combined automatic spot welding and heat-treating of alloy steels and heavy sections and permits the employment of relatively unskilled labor for spot-welding operations.

In general appearance, the new welder, shown in one of our illustrations, does not differ radically from conventional spot-welding machines. In operation, however, it employs a completely new method of control, the weld itself automatically controlling the functioning of the machine.

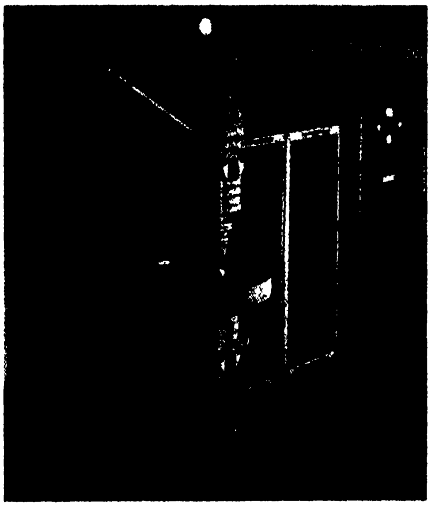
Up to now, resistance welding equipment has been operated mainly through the use of pre-selective controls regulating the amount of current and the duration of that current. The actual settings were determined by trial and error to give the best compromise for the "average" weld in a given material of a given section.

Actually, when operated in this manner, few welds are identical as to quality, because of variations in resistance due to varying metal thickness, varying induction losses as the material enters the throat of the welder, varying amounts of short-circuiting losses through previously completed welds in the same piece, variations in resistance due to the presence or absence of scale, and so on, and the gradual increase in electrode area due to normally unavoidable mushrooming.

It is for these reasons that many types of resistance welding operations have up to now required close supervision or handling by highly skilled personnel, especially when welding heavy sections and alloy steels.

The flexibility in operation of the "Temp-A-Trol" welder, in contrast, is demonstrated by the fact that—without changing the machine controls—welds of exactly equal quality can be produced consecutively in ¼ to ¼ inch, in 5/16 to ¼ inch, in ¼ to ⅜ inch, or in three sections of ¼ inch material at the same time.

In addition to this, the "Temp-A-Trol" welder can be used to automatically heat-treat the weld in the same operation. This post-heat refines the grain size of the weld, increasing its ductility, gives the proper grain structure, and "tempers" the weld nugget and adjacent area to any desired amount consistent with the characteristics of individual alloys. It eliminates the accepted "necessary evil" of coarse and brittle grain structures when welding alloy steels and heavy sections of other metals.



The weld controls the machine

To set the controls of the "Temp-A-Trol" welder it is necessary only to determine the temperatures which will produce the best weld and heat-treat characteristics in any given material. This is a relatively simple matter. The controls of the machine are then set to values corresponding to these temperatures. After the controls are once set, the machine will automatically compensate itself and reproduce identical quality welds under wide ranges of variation as to metal thickness, cleanliness of metal, and other welding conditions.

The basic element of the control which makes this possible is the incorporation in one of the welding electrodes of a highly sensitive thermocouple. This thermo-couple automatically shuts off the current when the correct temperature is reached, turns it on again when the weld has been cooled to the proper degree, turns it off when the correct heat-treat temperature has been reached, and so on.

Thus, instead of having a definite weld-time and welding-current with variable weld-quality, the new welder reproduces a definite weld-quality with automatically self-adjusting current and time cycles.

CUTTING OIL

Speeds Production, Lengthens Tool Life

Machines making parts for airplanes, tanks, ships, and guns are showing increased production and longer tool life with the use of a new industrial cutting oil recently perfected. In one recent demonstration, the new oil, known as "Cut-Aid," was used on a machine that was throwing up a plume of smoke while operating at 100 surface feet a minute. After the new cutting oil was added to the cutting lubricant already in use, there was not a trace of smoke at 300 feet a minute. At the same time, production was increased, tool life extended, and a better finish obtained on the work.

In another operation, in a prominent metal working plant in the East tool life was extended from three hours between regrinds to 11 hours in forming aluminum on a Brown and Sharpe automatic, reducing ¾" round stock to ¼". Finish improvement was declared to change from "fair" to "excellent."

"The new oil has proved ideal for machining aluminum—one of the most difficult metals to machine and one of the most important in the production of airplanes," says an official of the Gulf Oil Corporation, where the cutting oil was developed.

"With this oil, aluminum parts now can be machined so smoothly that in many cases they don't need to be polished, thus eliminating a full step in production. In shops where it has been used, machine tools cutting aluminum are setting new production records.

"The oil is also excellent for cutting magnesium and non-ferrous alloys and in many cases has set new standards of performance for this type of work including finer finish, and cleaner sharper, and more accurately machined threads."

The new oil was developed by Gulf scientists following eight years of study and experiment on animal oils such as the oils of whales, hogs, and fish. These oils were chemically broken down and their best properties synthetically reproduced, then blended with mineral oil to produce a cutting oil with the industrially desirable qualities just described.

INDUSTRIAL TRENDS

ON THE THRESHOLD OF ELECTRONICS

When this war is over—and almost all consideration of industrial trends in practically every field of endeavor must be placed on that horizon—the science of electronics is going to work at least a small revolution in many industrial operations. In order to gain now an appreciation of the possibilities of electronics in the future it is desirable to review some of the accomplishments of the past, on these accomplishments will largely be based the successes of the developments of day after tomorrow.

A broad definition will serve as a starting point for this combined review and peek into the future The science of electronics may be considered to include all controlled applications of the electron—basic part of every atom—to the uses of man. Thus the field ranges from X-rays and ultra-violet light to the radio vacuum tube, to power controlling devices, to power converters, to star counters, to the electron microscope, to innumerable other uses in almost equally innumerable other fields

The earliest familiar development in the then unnamed science of electronics was the X-ray, a laboratory curiosity that soon invaded the field of medicine and then branched out into many industrial ramifications The medical uses of the X-ray do not immediately concern us here, but its invasion of industry certainly does Thus, the X-ray has been put to inspection jobs in a myriad of factories, revealing hidden flaws, defective welds, foreign substances in packaged foods and other materials, and doing other similar jobs that, without the X-ray, would be left undone or would require destruction of the material. This latter phase is of particular importance now Testing to destruction, a method often employed to determine structural defects, is wasteful of time and material. Substitution of the X-ray's penetrating eye for the inspection-by-destruction process speeds up operations, conserves materials, and results in greater knowledge of what has actually taken place within a given structure during fabrication.

In other ray fields there are ultra-violet and infra-red, both as invisible to the human eye as the X-ray, yet each as valuable to industry in its own way On these rays are based lighting systems such as that using the fluorescent tube; drying methods that speed up painting, food manufacture, blueprinting, and so on; chemical processing procedures that cannot be carried out under visible light; sterilizing systems that kill up to 99 percent of the germs in the air; and so on almost to the limits of human imagination.

Just as the X-ray gave man new eyes with which to see through things, so has the electron microscope given him still another pair of eyes with which he can view the infinitely small. Already—the electron microscope is a practical development of only the last few years—many industries have gleaned much new knowledge of their products, knowledge that could immediately be applied to betterment of the products, of the processes employed, or both.

Then there are applications of the photo-electric cell to countless control jobs and of the ubiquitous vacuum tube to rectification and amplification processes, of electronic means for reducing the amount of smoke and dust in the atmosphere. These and many others are incubating in the laboratories of the world or are being reduced to practice, frequently under the hush-hush of military secrecy. It is largely this latter factor that prevents saying very much about the present-day status of electronics. Practically every development in this science, new or old, has military significance that must be kept under cover for the duration. It is no secret, however, that the push of military necessity is contributing hugely to the sum total of knowledge about electronics When the veil is lifted, a whole new story will have to be written about the applications of this science. And it will be a thrilling story, a story that will have its effects on every civilized person.

PETROLEUM, A BASIC INDUSTRY

Motor and other fuels constitute, numerically, only a small part of the products that have been made available from petroleum by the continuing process of research applied on a grand scale. As a result, the petroleum industry is asuming an increasingly greater importance in today's industrial picture, with promise of even more wonders to come. Where only gasoline and kerosene grew from crude oil but a generation ago, there now sprouts such a widely diversified group of hydro-carbon derivatives as anti-freeze and alcohol, high-octane fuel and butadiene, toluene and glycerine, ammonia and styrene

The foregoing short resume of petroleum products gives the key to future trends. Much of the development work that has made possible these products from the basic petroleum has been war-encouraged, and is going far toward assuring victory for the United Nations through the supplying of vital materials of war. This development, of course, is not going to stop with the end of the war; it is going to establish the petroleum industry as a supplier of raw materials to a host of other industries which will supply civilian needs in a manner never before possible.

War materials hold the center of the stage at the present moment Of these, none is more dramatic than toluene, basic necessity for high explosives Originally obtained from coal tar, toluene is now synthesized from petroleum at a rate undreamed of only a few years ago Proof: During World War I, toluene sold for some three dollars a gallon. Today it is quoted at about 28 cents a gallon In the same war field is ammonia, from which is made nitric acid, also needed for explosives manufacture Ammonia is now being produced synthetically from petroleum. And there is glycerine, still another explosives constituent, which came formerly only from soap manufacture, now it also is being obtained from petroleum.

Alcohols in great variety, important in many industries as solvents and extractants, are now petroleum derivatives So great has been the progress of this development that, it is said, some of these alcohols are being produced at such a low cost that alcohols from fermentation cannot compete with them.

Space permits touching only lightly on the products which the petroleum industry can extract from its raw material, products that, in turn, will become the bases of whole new industries in the future. Largely as a supplier of fuels obtained from crude, the petroleum industry has built up a vast integrated business that has proved its efficiency in the past. With such a background, coupled with the results of research and war-pressure, the industry as a whole should be able to keep up its rate of progress in the days of rebuilding after the war.

—The Editors

Star Populations

Have Our Existing Means of Observation Given Us True Samples of Spatial Objects?

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In studying objects of any sort, two things are necessary: first, to be able to find the characteristics of the accessible individuals; and, second, to find out whether these individuals form a fair sample of the whole population to be investigated.

The astronomer who applies this statement to the stars may be accused of using two words, at least, in the famous Pickwickian sense—"accessible" and "population." His justification for the first is clear. Distant as the stars are, his telescopes and spectroscopes and photometers really enable him to investigate their properties. As for the second, statisticians are accustomed to speak of a population of any sort of things, animate or inanimate, which form a definite large aggregate from which samples may be selected and studied—one may have a population of stars, or even of telephone calls.

In order that the sample which is studied in detail may be fairly representative of the population as a whole, two requirements must be met. It must be large enough to be statistically significant—and free from systematic selection. In a small sample, say of a dozen, the relative numbers of objects of different kinds will depend largely on chance, and important, though unusual, types will probably not be represented; but when the number rises into the hundreds, or thousands, it is probable that the percentages of different types found in successive samples of the same size would be nearly the same.

Even though this was found by experience to be true, the samples might not be fairly representative of the whole population. The individuals to be counted have to be picked out of the great multitude in some fashion; and it is remarkably difficult to devise a method of choice which does not favor some types at the expense of others.

In statistical studies of stars, modern astronomers are usually able to get fairly large samples to work with. Spectra — the most important single characteristic—have been observed for hundreds of thousands of stars, and we have at least approximate measures of brightness for over a million.

The apparent proper motions in the heavens are known for more than 50,000 stars, and the motions of approach or recession for many thousands. The number of stars whose distances have been measured runs also into thousands, and tens of thousands more are observable spectroscopically with existing instruments.

We can measure the colors, and get a good idea of the temperatures of as many stars.

In some ways we are more limited. We can find the masses of stars only if they are doubles in orbital motion, and their distances have been measured. Even so, about 600 systems are available. Densities can be found only for eclipsing binaries, but we already have data for some 200 of them, with many more awaiting observation.

We do not know nearly as much as we wish we did about the causes of real variability in brightness; but this is not for lack of material, for thousands of variable stars are known, and hundreds of them have already been observed in a fairly detailed manner. There are certain classes of variables —for example, the novae—for which we must wait upon time to send us more to observe; but scores of these are known, and eight or ten, at least, have been observed very fully.

The white dwarfs, a few years ago, formed an exception, an obviously important class with only three or four members; but persistent search has increased the number known to more than 20.

A search for unique objects would be most encouraging among the stars with peculiar spectra. But, even here, it is noteworthy that—so far as the writer can recall—there is hardly a single object which really stands alone. It looked as if this had happened at last, when the first spectrum of a super-nova was observed and found to be different from anything known previously; but the next super-nova had almost the same spectrum.

We can see so far into space, and there are so many stars there, that there appears to be a very good chance that anything that is seen once will be seen again within a few decades or less. There is nothing new under the sun—or in the heavens far beyond it.

There is really good reason to believe, therefore, that we have already observed examples of nearly all the kinds of stars or other luminous bodies that exist in space—though the recent discovery of super-novae reminds us that "there are as good fish in the sea as ever were caught."

We must never forget, however, that this knowledge, wide as it is, is subject to severe limitations. The greatest and most unescapable of these is the obvious one that we can observe only what we can see (treating photography fairly enough as another kind of vision). Anything which is the object of astronomical study must either give out light on its own account, because it is hot, like the Sun and the stars; or shine by reflected light, like the planets and some diffuse nebulae; or give out light of its own when stimulated by the light of a near-by star, like comets or gaseous nebulae; or, finally, obstruct or absorb light, whether in general, like the dark nebulae, or in particular wavelengths like the gases in interstellar space, or in the atmospheres of the planets. There is one exception: a dark body may reveal its presence by the effects of its gravitation, producing orbital motion in a luminous companion. The faint companion of Sirius, first discovered in this way, was later seen telescopically; but there is reason to believe that some other such stars may be substantially dark. But even this exception would be unknown to us if the companion star did not shine.

This limitation excludes from our study all cold bodies outside our own planetary system. We can predict from general physical principles what they should be like. Large masses (more than 100,000 times the Earth's) must be intensely hot inside, gaseous throughout, and self-luminous—in fact, stars—unless they have reached the degenerate state of enormous density, which the white dwarfs approach. Masses 10,000 times the Earth's should settle down into a partly degenerate condition, in which they would be cold and dark; those less than 1000 times the Earth's should, like the planets, have cores of ordinary solid matter—the larger ones with very extensive atmospheres like Jupiter, the smaller, with little or none, like the Moon; and from this there should be a continuous gradation through bodies like asteroids and meteorites down to fine dust, and at last to individual molecules and atoms. At the bottom of the scale, the particles are so enormously numerous in many regions of space that they produce observable absorption effects; but there is a vast intermediate range of size within which they are hopelessly unobservable.

From the rotation of the galaxy it follows that the total gravitating mass in it is not many times greater than that of the luminous stars. A considerable part of the excess is doubtless accounted for by the dust and gas; but there may still be a large amount in the form of dark bodies. On a census of individuals, these may be very much more numerous than the lucid stars—or perhaps not. We have only this to go on. When we try to count the stars in a given volume of space—preferably in the region close to us—we find that the great majority are fainter, and less massive, than the Sun. The numbers increase as we go to still fainter and smaller bodies—indicating that there are a great many more beyond the limits of our study

THERE is some evidence that the rate of increase slows up, and perhaps almost stops, for the faintest stars which we can observe. We can reasonably extrapolate and say that there must be enormous numbers of bodies of one tenth the Sun's mass, but beyond the limit at which bodies would settle down into a solid, rather than a partially degenerate state, we cannot safely estimate.

We have as yet no idea at all why or how so much of the matter in the galaxy ever came to segregate into huge lumps like the stars. It is in fact hard to see how this could happen, if we start with the conventional assumption that the matter was "originally" distributed with rough uniformity through galactic space. On this basis, the stuff that ultimately formed a star would at first have been distributed through a volume at least a light-year in diameter. Unless the relative motions within this scattered assemblage were exceedingly small, the mass, when it shrank to the dimensions of a star, would be rotating far faster than the average star—indeed, it would have too much rotational momentum even to form a wide binary pair.

Yet, if the galaxy as a whole was rotating, as it does now, about a central condensation containing a considerable part of its whole mass, the attraction of this condensation would pull apart a configuration as exceedingly tenuous as that just described, and prevent it from condensing at all.

We do not know, of course, whether, when the stars were formed, the galaxy—or the matter which grew into it—was of its present size. The theory of the expanding universe points the other way But, in our complete ignorance of what actually happened, we have no basis at all for even guessing how many smaller masses were formed in the same process.

THIS we do know: our methods of observation give an exorbitant, and almost incredible, preference to the stars of great mass and luminosity. Our capacity for observing a star depends not on how bright it *is* but on how bright it *looks,* and hence very largely upon its *distance.* The stars visible to the naked eye, for example, run down to about the limit of spectroscopic observation in full detail with high dispersion. To be thus visible, a star of the Sun's real brightness must lie within a distance of approximately 50 light-years—and we find a considerable number of these. But a star of 1/100 of the Sun's luminosity will be visible without a telescope only if it lies within five light-years There are dozens of stars of about this brightness within 50 light-years, but a five year radius occupies only a thousandth part of the volume of the larger sphere, and it is not surprising that we do not find one within it. Inside this small sphere, we know of only three stars — the bright double Alpha Centauri, and its very faint distant companion often known as Proxima Centauri. This tiny star is but 1/25,000 as bright as the Sun

If, on the other hand, we seek stars a hundred times brighter, in reality, than the Sun, we can see with the naked eye all that are nearer than 500 light-years. Our vision ranges over a thousand times greater volume of space than for stars like the Sun. If they were distributed in space as thickly as stars of the Sun's brightness, our list of stars visible without a telescope should contain a thousand times more of the brighter sort than of the fainter. This is remote from the facts; something like half the stars in question belong to the brighter group—or those still brighter, and one or two percent to the fainter group. In our list of "bright stars" those of high luminosity are therefore preponderant in the proportion of (roughly) 30 to 1. But, when we apply the obvious correction necessary to pass to the numbers of stars in the same volume of space, we find that the fainter stars are in an even larger majority.

The brightest super-giant stars, such as Rigel and Alpha Cygni, exceed the Sun 10,000 times or more in brightness. Such a star would be visible to the naked eye at a distance of 5000 light-years. Among the 22 apparently brightest stars there are the two super-giants just named, and only two which are comparable in real brightness with the Sun—Alpha Centauri and Procyon. This is a small number to argue from; but if space were uniformly filled with stars it would indicate that the super-giants were about a million times less frequent, in a given region of space, than stars like the Sun. This is an exaggeration for two reasons. first, a distance of 500 light-years extends on both side of the galactic plane, into vast regions where the stars are thinly scattered; second, at these great distances we must reckon with the absorption of light by the thin dust-haze which fills the galaxy and makes remote stars look fainter than they otherwise would.

MAKING a liberal allowance for these, it nevertheless follows that the necessary limitation imposed upon us by the selection of stars bright enough to observe gives the super-giants an advantage of at least 10,000-fold against stars as bright as the Sun, and of many a billion times against the faintest dwarfs.

We must therefore be cautious about the interpretation of direct counts of the stars. For example, almost all the stars which present marked peculiarities in their spectra are found (when we can investigate the matter) to be of high luminosity. The assumption that peculiar spectra in some way not yet understood were naturally associated with a great real brightness is tempting. But if one in a thousand of the highly luminous stars is peculiar, we shall stand a good chance of finding not one, but a good many such stars among the million stars which appear brightest in the sky, and are visible in a small telescope.

The stars of one percent of the Sun's real brightness will constitute but a very small fraction of these stars (since we can see them only when they are near us) and an equally unusual peculiarity may stand a very good chance of being missed altogether for lack of an adequately large sample to study.—*Princeton University Observatory, October 1, 1942.*

The Folsom Mystery

Its Solution is Largely Contingent on the Solution of Another Mystery

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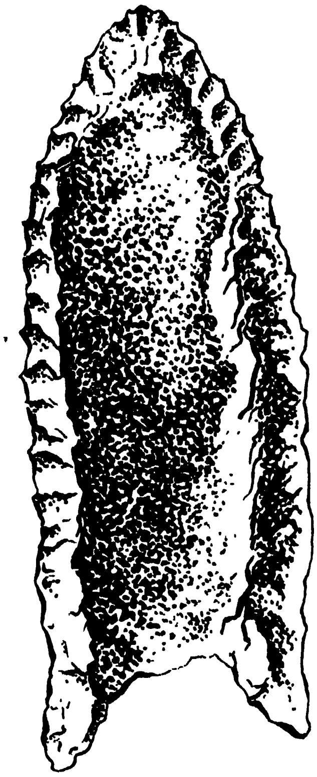
No mystery in American archeology has been more fascinating than that of the Folsom culture. In the 15 years that have elapsed since the original site was excavated at Folsom, New Mexico, archeologists have diligently pursued every clue that might shed a ray of light on the shadowy "first" Americans. Their subsequently discovered sites, scattered over a wide area in the High Plains region of the United States, reveal little about them except that they were hunters of animals long since vanished: extinct American camels, bison larger than the historic variety, strange South American sloths, and even the huge American elephants, the mammoths. Their characteristic hunting tool, a grooved, exquisitely fashioned "point," superior in workmanship to any other variety of point known from the New World, speaks eloquently of their artistry and skill. But, so far, there is little else except these peculiarly shaped, beautifully made "Folsom" points to speak for the intrepid hunters who made them. Tantalizingly, his unmistakable weapon, but not Folsom Man himself, appears in site after site associated with the now-extinct animals which he hunted.

Although geology has brought corroborative evidence to bear on the antiquity of Folsom Man, it is paleontology, the study of fossil animals, that has so far offered the most revealing clues. There is no longer any doubt that the association of the Folsom point with the bones of extinct animals is real and not accidental. The first discovery, in 1927 at Folsom, New Mexico, of peculiarly shaped implements of human manufacture associated with the bones of a species of bison supposedly extinct since the closing period of the Ice Age, has since been duplicated in other regions by scientists whose investigations were conducted under conditions imposing the strictest control. But the question of the exact age of the Folsom culture is still a controversial subject *revolving largely around the question of when these large Ice Age animals actually disappeared.*

Most of the geologists and students of fossil animal life who have attempted to aid in dating the remains take the view that the last of these animals perished in the closing period of the last glacial retreat some 15,000 to 25,000 years ago. Some, however, express the belief that many of these archaic beasts lingered down into a period perhaps as late as 5000 B.C.



Typical Folsom point

The animal most commonly hunted by Folsom Man, and hence most commonly used for dating purposes, seems to have been a species of buffalo slightly larger than the existing species and somewhat more powerfully horned. It is commonly termed *Bison taylori* by scientists, in contrast to the term *Bison bison* applied to the living form. Beyond size distinctions the animal's skeleton is not markedly distinct from the living bison which, as a matter of fact, may be its direct descendant. At all events, *Bison bison*, the living form, seems clearly to succeed the older Ice Age bison, probably at the termination of the last glacial withdrawal. The larger form was doubtless adapted to enduring greater extremes of cold, and may have failed to hold its range as the post-glacial climate began to swing toward a warmth maximum to which the animal was ill adapted. Instead, a new and smaller bison, perhaps developed from the bigger species in more southern areas, flows in over its receding range. Whatever the cause, *Bison taylori* vanishes from the High Plains and the historic (living) buffalo succeeds him.

Whether the larger animal followed the ice back northward and lingered there beyond its survival in the United States is a problem which has received little consideration. No data have been available, and both paleontologists and archeologists have concentrated their attention upon the problems of the more immediate area. Hidden away in old books, however, discussed by naturalists interested only in existing animals, a curious broken thread of clues winds backward into the days of the first voyageurs who explored the Great Northwest. If these clues are comprehended in relation to the archeological picture which we have just discussed, they take on a strange and almost startling significance.

As the first explorers and hunters drifted into the region around Great Slave Lake and wandered through the valley of the McKenzie River, they found bison to be present in large numbers, even in this far northern area. As acquaintance with these animals was extended, hunters began to comment that these northern buffalo were larger and differed somewhat in habits and appearance from their southern relatives of the Great Plains. Though difficult of access and hence viewed by few scholars, these distinctions were eventually accepted as valid and the big northern bison came to be regarded as a more rugged variety of the southern animal.

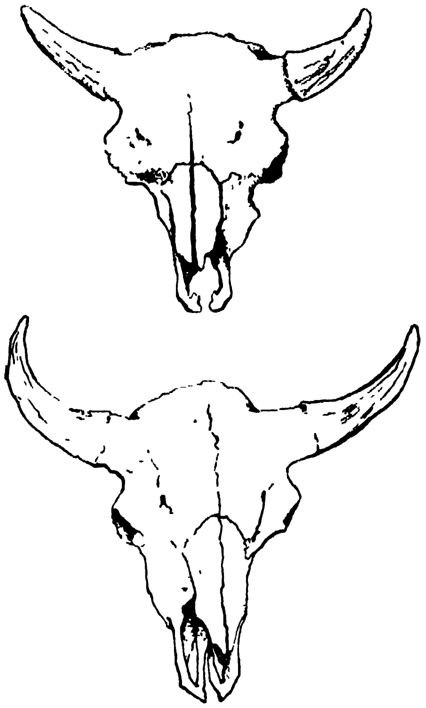
Eventually, in 1897, a naturalist named Samuel Rhoads undertook to describe the type and establish its scientific validity by giving it a varietal name. As a consequence, the animal has since been known as *Bison bison athabascae*. Unfortunately, most of the measurements which exist are hunters' measurements upon the body and are of little value in making comparisons with the skulls of extinct animals found in the form of fossils.

Rhoads published a few figures, however, and the writer has had access to a few others. These figures tend to bear out a very interesting point which even Rhoads saw fit to hint at in a tentative way: namely, that these big northern bison in certain measurements fell within the size range generally regarded in the United States as representing only the fossil forms of the closing Ice Age. Though, as one might expect, there are contradictions and discrepancies in the various accounts, the earlier literature, in particular, is emphatic upon the subject of large size and greater length of horn. The measurements across the forehead from the base of one horn core to the other are much greater than in the southern bison and as large as in the fossil forms found associated with man.

At this point a question must inevitably occur to the reader. These northern bison, whether or not we attempt to relate them to the fossil bison found associated with early man in the Plains region, are a cold-loving form. Where were they when the ice sheets lay across Canada? Obviously it would seem that their range must have been pushed much farther south How, then, can we ignore the fact that this big animal may also have been hunted by early man in the High Plains region, or even the suspicion—call it no more than that—that *Bison bison athabascae*, at least in a reduced and mixed fashion, bears some intimate relationship to the big Middlewestern bison of the closing Ice Age? Even if, like some scholars, we merely regard the present northern bison as a climatic phase of the ordinary Plains bison, the question might still arise whether the fossil bison species known as *taylori* could not then be viewed as a similar and even more vigorous reaction to glacial conditions.

Since the surviving northern bison now inhabit a Woods bison preserve in Northern Alberta, it would seem at first glance a very easy matter to settle some of these problematic relationships by a more extended study devoted to detailed comparisons of the skeleton of this bison with that of the fossil forms hunted by the Folsom people. Here again, however, the problem is much more complicated than it appears.

The number of Woods bison declined greatly during the 19th Century and at one time was estimated to be as low as 50 head. In 1893 the Canadian government passed the first laws attempting to protect them. A slight upswing in numbers took place. Then, in 1925, the Canadian government carried out a policy which the American Society of Mammalogists vigorously but fruitlessly protested. Large shipments of Plains bison were introduced into Woods Buffalo Park and a large-scale intermingling of the two types took place. Clearly it is now impossible to be sure of the strain represented by an individual bison. The number of unmixed animals must now constitute a very minute, if existing, fraction of the herd.



Skulls of *Bison bison* and *Bison taylori*, showing comparative sizes of skulls. Drawings by the author, from specimens in Nebraska State Museum

In drawing attention to the tantalizing similarities between descriptions of the fossil species and that of *athabascae*, the existing northern form, it must be remembered that no really thorough comparison is possible in the present state of our knowledge Nevertheless, the implications of similar body size make it impossible to ignore the fact that the northern bison, at least as it existed in early historic time, may have actually represented a type somewhat more archaic than the Plains bison. If, as seems likely, the fossil bison pursued by the post-glacial hunters of the Middlewestern United States was a form adapted to colder winters, it may have lingered for a time in the Canadian areas, perhaps being slowly bred out as a pure type. If the animal survived in this form, it is unlikely, in spite of its temporary isolation during the 19th Century, and its preference for a forest habitat, that it escaped contact with its southern relative during the days of the great herds.

Evidence is not lacking that a gradual increase in horn size and ruggedness extended from the south to the north in geographic sequence. Such a sequence may suggest that the transition from the fossil to the living form was progressive in both area and time Only the onset of post-glacial warmth would seem to suggest an adequate causative factor.

In the light of the evidence we have here summarized it would seem that a reasonable possibility exists that this inadequately known phase of the living bison represents, at least in a mixed and dying way, the blood strain of the cold-loving bisons of the late Ice Age.

Whether or not this interpretation is correct, the southward extension of the range of this species during the last ice advance cannot be ignored as a possible confusing element in the study of bison remains from archeological sites where complete skulls are missing. In the size of leg bones the living *Bison bison athabascae* could not be distinguished from the fossil form. Inadequate study of both animals, as well as a dearth of fossil evidence from the Canadian areas, has shrouded in mystery both the disappearance of the fossil species and the appearance of its successor, the existing Plains bison.

Where the big northern woodland bison belongs in this succession of forms can be revealed only by much more thorough research than has as yet been attempted In so far as evidence exists, however, it is not adverse to the view that these bison may represent an archaic form existing only as a marginal remnant, now fast disappearing

Nevertheless, even if we could prove that the northern bison bore a very close relationship to the fossil type, we could not, on that basis alone, argue that man's occupation of the Great Plains was extremely recent Only the last great ice withdrawal seems adequately to explain the change in the type of bison in the western United States

Undoubtedly the relationship between the big woodland bison and the fossil species hunted by Folsom Man demands clarification. When this is successfully accomplished, we may be much farther along the road toward dating those mysterious forerunners of the American Indian in the Great Plains

Official U. S. Navy Photograph

The destroyer *Shaw*, in Pearl Harbor on December 7, 1941, shortly after Japanese aerial bombs made direct hits. A false bow got her back to a West Coast yard

Broken Ships Made New

Fast Work by Civilian Engineers is Getting Allied Warships Back Into Service in Record Time

DAVID O. WOODBURY

It is no secret that American warships are taking a battering by the enemy and that some of them are limping home from the battlegrounds of the seven seas, ripped and broken and urgently in need of repair. Half ships, backs of ships, fragments of ships sometimes—destroyers with their bows blown off, submarines torn asunder as if a giant can opener had done the job; corvettes with whole broadsides open to the waves, cruisers with masts down and decks tangled with steel.

In the early part of the war it was German psychological strategy to claim a ship sunk as soon as it was hit. For a while after Pearl Harbor the Jap used the same ruse. But neither enemy does so now. Too many Allied ships have been knocked to pieces only to reappear again better than new, actually stronger in armament and up to the minute in every essential detail. The Axis has learned to fear the vessels it has crippled but not destroyed. The enforced rest period for repair gives our navies a chance to catch up on the latest wrinkles of battle-tested equipment and to send their ships back to sea more formidable than ever.

The secret of this work of renovation — most of it accomplished in American navy yards—is the lightning speed our technicians have developed in making repairs, speed and ingenuity born strictly of the emergency. Feats of reconstruction are being done today which even a year ago would have been called impossible Before Pearl Harbor a sunken hulk like the bombed destroyed *Shaw* would have been left to rust at the bottom of the bay. But after the Japanese betrayal a new spirit of "can-do" hoisted the *Shaw* out of her grave, fastened a false bow on her, and sent her 2000 miles to a West Coast navy yard for permanent repairs. Now she is back in the fighting line, a deadlier ship than when she was first built. The whole job took three months. A similar rebirth awaits the cruiser *Marblehead,* whose blasted hulk was sailed half way around the world from the Battle of Java to an American port. In ordinary times such an effort would have been absurd; today it is part of the routine of the new warfare.

The credit for performing these miracles of rejuvenation goes to a group of young engineers in our navy yards who have developed methods of their own, not out of books or conventional practice, but out of their own heads. These surgeons in steel are not of the Navy at all, but are men who have joined the show since the war began. A few months ago they were landlubbers with little knowledge of ships and a merciful ignorance of official red tape. The steadily increasing number of damaged ships limping home appealed to their imagination and they asked to be taken into the Naval Reserve so that they might exercise their special talents while the regular Navy men went to sea. Gladly their request was granted; the Navy was not dismayed by the fact that they had no formal training in marine construction. It simply told them to go ahead and do the best they could. Today they are the world's foremost experts in sending broken ships back to sea.

Officially this gang of young bloods is known by the prosaic title of Navy Yard Hull Superintendents. But in fact they are gamblers who play the last ounce of mechanical ingenuity against time Operating on their own responsibility in what amounts to an administrational vacuum, they turn out seven-week jobs in three weeks, five-day repairs in a single night, and seemingly achieve the impossible with every problem they undertake. They are little known outside the yard gates and they receive no medals. But they are patriots none the less. Voluntarily they have sacrificed good civilian salaries, given up their private lives, thrown away their holidays and spare time, all because they have discovered a vital way to help win the war. They are young, angry America stepping up front to fight.

How they work is typified by the example of a young lieutenant who may be called McCantry, on repair duty in an Atlantic Coast yard. Not long ago a battered warship was on her way in from sea, her "availability" for overhaul only eight days. This ship had been on action station for months—some 40,000 miles of sea duty without a break. Officers and crew were weary from weeks of confinement in her battleshaken interior. To get back to work their vessel must be renovated from stem to stern—in eight days. They were angry particularly because they knew that this could not be done.

Commander Gurney, the Boss Hull Superintendent of the yard, was the first to hear of her coming by radio. He took a quick look at the work board in his office and summoned McCantry. "Do what you can, young fellow," he ordered. "Put her in Dock Four and turn the yard loose on her. I'll inform your wife you won't be home."

Mac grinned; this was a challenge such as he loved to meet. Pulling the telephone to him he began rounding up his forces. All over the yard shop bosses and estimators threw on their coats and converged on a Navy tug at the pier. Within ten minutes McCantry and his men were on their way down the harbor to meet their ship. Their timing was perfect. Within half an hour they had scrambled aboard the tired warship and were on their way back to the yard. During the trip they had just 30 minutes to complete their inspection and lay their plans.

Skilfully Mac surveyed the damaged ship. There was certainly plenty to do. Hull plates sprung on the port side, super-structure cluttered with wreckage from a direct bomb hit, mast out of line, small boats smashed, gear of all kinds gone adrift. In the wardroom, however, he made no comment, only asked for details. The Executive Officer threw a list on the table. It was ludicrous in its length. New A-A guns, new cranes for the boats, new magazines and fire control; hull plates removed and straightened, mast reset. Acid lockers and fuel tanks cleaned and relined, radio equipment replaced, crew's quarters remodeled, windlasses, anchor gear and steering equipment overhauled. Ventilating system, boat cradles — everything — pulled down and refitted. From fighting tops to keel plates the ravages of uninterrupted battle service had to be erased. And at the bottom of the list was this: Complete overhaul and repair of potato-peeling machine.

THE Executive Officer grinned wryly. "Here you are, Lieutenant. Do whatever you can in a week."

Most of those jobs were major operations—a month's work at least, by pre-war standards. But McCantry had learned to work differently. Snatching a pad and pencil he began to break down the list and pass the sheets to his various yard bosses amid a cross-fire of discussion and orders. There was no time for formal blueprints or routine procedure. Every foreman must carry his part of the work in his head or scratched on the back of an old envelope. After this one conference there would be no further powwows. If difficulties arose they would have to be solved empirically, on the spot.

Official U. S. Navy Photograph

The *Shaw*, with temporary bow in place, has returned to the United States for final repairs and the installation of a new bow. She is now deadlier than ever

When the Navy Yard was reached Mac's plan of campaign was complete.

In the hour and a half required to drydock the ship the young hull superintendent rounded up his supplies and set the various shops in motion. The dock was not yet dry when a thousand men, drawn from every department, began swarming aboard with their tools. Power lines were going up, portable machines were swinging aboard from overhead cranes, stagings were being lowered over the ship's sides. While the sailors scurried ashore to be out of the way, workmen were penetrating into every compartment, each charged with a specific job.

Already familiar with the ship's layout from stem to stern, McCantry established a route of inspection and began circulating methodically, showing each riveter and welder, carpenter and linoleum layer how to work without interfering with his neighbor; keeping up the tempo with a cheery word or a bit of advice or praise. The important thing in an emergency like this was to set the pace and maintain it. It was a battle against time. The men all knew their jobs, all they needed was the example of a boss ready to sacrifice himself to the limit to accomplish the work. So, through the first day and night and the second day Mac remained aboard continuously, without sleep, carrying a sandwich in his hand and a bottle of pop in his pocket. By the second night things were proceeding so well that he kept on until the unrelieved stretch had lengthened to 66 hours. Only then was he so sure of success that he could throw himself down on his office desk to snatch a few hours of badly needed sleep.

IT was McCantry's hunger for punishment and his calm assumption that every man under him could take it as well as he could himself that put this job through. At the end of six days and nights, with all hands working 16-hour shifts, the ship was completely repaired and renovated. Every item in the list was checked off and done, even to the overhauling of the potato-peeling machine. On the seventh day the vessel was ready for sea, better than new.

The secret of wartime repair lies in the democratic system of free enterprise and individual responsibility. Each new job is pushed through to success in record time because it is a complete campaign in itself, under the guidance of a man who is in an individual race against the enemy. When the need for high-speed repair first hit the yards no one knew how to meet it. The hull superintendents were kindergarteners then and the Navy did not expect very much of them. But it had no choice but to turn these reserve technicians loose and let them try. What these Commandos of the shipyards did with the opportunity has set a new American standard for high-pressure work which has been copied in every shipbuilding yard in the country.

McCantry and his companions cut their eye teeth on the Allied warships that limped into our yards in 1940 and '41. These foreign casualties were especially tough, for they had been through the combined infernos of Crete and the Western Approaches, surviving attacks by torpedo, naval gun, and aerial bomb. Some of them were almost total wrecks—floating junkyards that even their owners despaired of saving. Moreover, they were built in a different style from our own. Thousands of small fittings—valves, bolts, pipes, and machines—were of slightly different design and could not be replaced out of American stock. Many a repair part had to be made up specially for the job, often by hand in a machine shop or foundry. From the start this kind of work taught the young technicians to improvise, taking whatever they had on hand and making it fit. When standard steel plates were not wide enough, they patched smaller ones together by welding. When American electric lamps didn't fit foreign sockets, they ripped out whole wiring systems and put them in new.

Every visiting ship carried a full set of plans by which repairs were supposed to be possible—in their home yards. But many of the specifications couldn't be met in America. So the hull superintendents sometimes had to ignore the plans altogether, inventing new layouts and construction details as they went along. Thus they made a virtue of necessity and soon had developed the habit of solving their problems out of their heads, leaving standard practice behind They knew the results required; how these were achieved mattered little so long as the job was done quickly and with success. It was an engineer's paradise. With the huge resources of the yards at their backs they could build new ships out of old ones with no other limit than their own ingenuity and endurance. The old complaint that "it can't be done" had become for them a challenge and later a guarantee of success.

Our allies, desperate for ships, were incredulous. When a great dreadnought came in for repairs the British feared that the job would take a year. Her wounds, though not publicized, were extremely serious. At the end of 70 days she sailed again, a new battleship with many improvements suggested by the loss of the *Graf Spee*. The British were delighted. As many as possible of her naval casualties are now sailed to American yards for repair.

The heavier the steel of a warship's hull, the tougher the problem of cleaning her up after bombs and torpedoes have torn her apart A typical case of heavy repair confronted a sandy-haired young ensign named Mullins, who had graduated from engineering school less than two years before joining the Reserve. He had to get this ship into drydock without permitting her ragged bottom plates to smash up the dock flooring on the way in. Coolly he had her crew make the ship fast to a pier in deep water. Jumping into a diving suit he went down with a couple of professional divers with underwater cutting torches. The three of them spent all day and part of the night cutting loose jagged pieces of steel, constantly in danger of having their life lines cut by the knife-sharp edges all around them. Mullins had never been down before; without practice he shouldn't have gone. But he wanted to save time by applying his knowledge of cutting methods directly to the job in hand. As a result the ship was drydocked a full half day ahead of schedule and repairs beat every previous record set by the yard. Mullins's example in that first risky operation had put every workman on his mettle.

Official U. S. Navy Photograph

The *Shaw*, in drydock on the West Coast, with her new forward section shown in the foreground ready for installation

These young hull superintendents wear the uniforms of Reserve officers of minor rank—indistinguishable from thousands of others who do our naval fighting and patrol. But their authority is out of all proportion to their stations; it is unique. To be in charge of a whole warship under repair is to be the boss of every civilian on the job and to have priority to get things done immediately in all the shops. It means that the young engineer must know every compartment on the ship, understand the purpose of every beam and plate and every machine, and know how to find any kind of trouble and set it right. In addition, he must handle his men skilfully and get along with every yard boss into the bargain.

He is working on his own, with millions of dollars worth of ship at his mercy. Actually he is tied solidly into the navy yard organization in a position that is simply streamlined to fit the emergency. In each of the yards he and his colleagues report to a Chief Hull Superintendent—a naval old-timer who parcels out the work and keeps a seasoned eye on his little group of virtuosos. The Chief in his turn is responsible to the yard's Construction Officer, who is directly answerable to the Commandant. None of these three head men tolerates red tape. In this repair job there is something of the spirit of the research laboratory, where independence and initiative are 90 percent of the stock in trade. Only one requirement is held over the men: they must get their work done right, in record time. How they do it is their own affair. They must work out their own contacts with departments of supply and manufacture and transportation. Nobody interferes with them unless by their failures they prove themselves unequal to the job.

In peacetime such tremendous responsibility on young shoulders would be impossible. But results have proved repeatedly that lifelong experience is not necessary. Ingenuity and plain common sense get the hull superintendents out of every jam. When they come to the yard they do not enter any long course of training, but are given a repair job and told to go ahead. If they make mistakes they must rectify them as best they can. The Navy knows that these fellows have been used to independence. Their great contribution will be innate judgment and the energy of youth. The Navy has learned that when a man has no time to make mistakes he won't make them.

Official U. S. Navy Photograph

A close-up of the operation of joining the *Shaw* to her new bow. The ship, at right, is being floated into position for attaching the bow which is seen at the left

The hull superintendents are drawn from all over the land—from industry, business, laboratories, sometimes from college graduating classes. Admiral Yarnell, of China fame, is credited with the idea of digging them out and giving them a try. When the repair problem threatened to become serious he persuaded the Navy Department that industry was full of young engineers who would make top-notch fixers of damaged ships. He made a tour of the technical colleges and large corporations and interviewed hundreds of men from 25 to 30 who had shown outstanding ability along engineering lines. He told them there was a big job to do in the yards; that, although he could offer them little money and no fame, they would have an unbeatable opportunity to serve their country by doing the work they knew how to do best. If they would come he would see to it that red tape was cut and that the sky was made the limit for results. They took him at his word and joined the Reserve in droves

Official U. S. Navy Photograph

The *Shaw's* temporary bow has been removed; ship (in background) will be floated to new bow

McCantry, for example, was a welding specialist for a large manufacturing outfit Mullins worked for a farm machinery concern. Young Johnson had been a naval architect with the Maritime Commission Teale had a small consulting firm of his own. These men and many more like them had been uneasy in their civilian jobs for some time. They wanted to get into the game but saw no way of making their special talents useful. Then came Yarnell's offer and inside of a month they were repairing ships.

Men like Martin and Baker, cement plant engineers, had been responsible for many short-cuts and improvements in their own line. Both thought they had something to give the Navy and both joined up. Martin had once been a football man and Baker was a tennis star; both knew the value of quick independent decisions and at the same time understood team play. In their Nebraska home town they were told they were crazy to go to sea, but neither listened They went to West Coast yards and began.

BAKER specialized in destroyer repairs and eventually sailed with a gang of mechanics to Pearl Harbor just in time for the Jap onslaught. When the *Shaw* made her place in the news by rising from her grave and making the run back to the States under her own steam, the Japanese were puzzled, for they had seen the ship's magazine explode, ripping 50 feet of bow clean out of her. The mystery was easily explained. Ensign Baker had asked permission to try an improvised salvaging operation. Getting it, he had hauled the wreck into drydock, cut away several hundred tons of mashed plates and beams and then calmly welded a mud-scow bow over the *Shaw's* wide-open end It was not a new trick but the time record for such a job had never been approached before. And time was now more valuable than gold.

There are other men like Baker,

Official U. S. Navy Photograph

Once more a whole vessel, the *Shaw* is a monument to the spirit that will eventually emerge victorious

working at Pearl Harbor on jobs that can't be described. Regular Navy and Reserve are on duty there together, and the hull superintendents are hanging up records as good as or better than the *Shaw's*.

These Reservists are successful largely because so much is expected of them. One fellow named Smith, in an East Coast yard, makes a specialty of long hours. Twice recently he has gone for 36 hours without sleep when small patrol boats had to be repaired in a hurry to get back to the Atlantic submarine hunt. Smith gets home on an average of once a month and then only for a few hours. He has a cot set up in his tiny office and lives largely on sandwiches and coffee handed him by the crews of the vessels he repairs.

Another hull man named Telford prefers trick jobs, the less routine the better. The Boss Superintendent knows this and gives him every mechanical impossibility that comes along. Telford's high-water mark was a vessel with a smashed mast and a lot of topside damage that had to be sent to sea in three days. It was 24-hour work all the way through. He had to make and install a new mast, which he did in the rigging shop complete. It was ready to set on the last night, 12 hours before sailing time. Telford decided to set it himself. And so, about midnight—moonless, pitch dark, the wind whistling through his baba coat—he climbed aboard the spar and rode into the sky at the end of a wire rope sling suspended from a hammerhead crane far overhead. Then for three hours he jockeyed the mast up and down, easing it into place in the ship by signalling the crane operator above him with a flashlight.

It was a grim job but Telford himself was not grim; he was almost blythe. All through the night he swung in the air, singing, and his song carried through till dawn. And though Telford was pretty well frozen, pride sent him below to try a piece of thin paper between mast butt and seat when the job of lowering was done No mast had ever fitted before on the first try but this one did. Lieutenant Telford had made the measurements for it himself and was not in error by a thousandth part of an inch.

Gleeful victories like this go on day and night in every yard. Word came to one hull superintendent named Deane that half a dozen "PT-boats' were urgently needed "somewhere south." Deane revolved the problem in his mind and quickly eliminated all the orthodox solutions. The PT's were too small to make the long trip by themselves and too big to be shipped by rail. So he decided to load them aboard a converted merchantman scheduled to leave the yard next morning.

Grabbing a ruler he went aboard to make measurements. As he expected, the 'tween-deck space was too low for stowing the boats and nothing could be done to improve it. The only way out was to dismantle the boats and send them south in pieces Calling in the boat manufacturer to give him help, Deane quickly stripped them of everything—guns, torpedo tubes, masts, pilot houses, and all. Plywood bulkheads were ripped out by main force. He knew that others like himself could put the little craft together again on arrival.

In the middle of the night—as usual—he was ready; the PT's had been trimmed down to fit. Taking a boss rigger up on the ship's fo'c'stle he established communication by flashlight with the crane operator 160 feet above and the PT's began to swing through the air toward the cargo hatch. As the first one inched down Deane realized that the hatchway wasn't quite long enough to let her through. At any other time the whole plan would have been scrapped as impossible. Figuring rapidly, Deane decided to drop the boats slantwise, nosing them through the hatch and hitching their sterns in last. It was a delicate operation in the dark but it worked, with a trifle less than one inch to spare. The whole flotilla was snugged down in the hold by morning without scratched paint on any one.

The spirit that sent the pioneers across the Plains and drove back the frontiers of science in the laboratories is sustaining these youngsters through their long night vigils and daily grinds. What keeps their courage up is their perpetual interest in something new. Every repair problem is a fresh challenge, prefaced by the near conviction that it can't be done. What the Navy has done is to let loose the native American love for invention. These hull superintendents are never held down by routine. Their energy is never sapped by long waits while red tape unwinds. Nor is it falsely buoyed by hope of recognition or financial reward. They will never get medals or newspaper headlines But they will get something else that means more to them than all of these—the certain knowledge that without them many a ship would never again meet the enemy.

For the millions who must remain in civilian life this vital achievement of the Naval Reserve is a heartening thing indeed. It proves how strong are the sinews that lie dormant in a nation whose enemies once crowed that it was too soft and too slow For the McCantrys and the Mullinses, the Deanes and Telfords, the Bakers and Smiths are no different from ourselves and each of us will be capable, when the time comes, of turning in as good a performance as theirs.

●

¶ *THE foregoing article tells the story of only one of the many groups of unsung heroes who, just as much as the soldier, the sailor, and the marine, are doing more than their share toward winning the war. The stories of others of these groups are being ferretted out, and it is hoped that, censorship permitting, more than one of them will be published in the pages of this magazine.*—The Editor.

Contact Lenses

With Recent Advances in Technique, These Aids to Vision Have Become Much More Satisfactory

ALSTON CALLAHAN, M.D.
Atlanta, Georgia

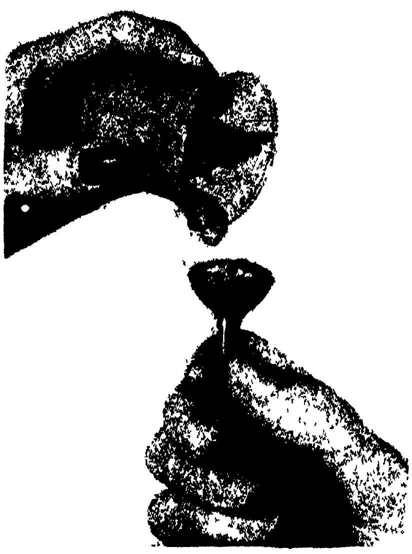
"INVISIBLE glasses? Contact lenses? You mean the kind that you put underneath your lids right against the eyeball? Ugh! I don't think I could stand them. Are they safe? And aren't they frightfully expensive?"

Many react in such a manner when the subject is mentioned, and it is true that the aversion to putting something into the eye is natural. But here are the facts.

It is only in the past few years, since clear plastics were devised, that the safety of contact lenses has been entirely beyond dispute. Also, it is only in the past few years that their construction has been scientifically accurate. Today, there are between 3000 and 5000 wearers of contact lenses.

Until recent years contact lenses were made only in certain sizes This required an exhaustive sitting while the user's size was selected, necessitating insertion and removal of dozens of lenses in the attempt to find one having the correct fit. The contribution which has now made contact lenses far more usable was made by T. E. Obrig, a New York optician, who pioneered in making molds of the individual's eye, entirely of plastic material, so that the fit was as precise and individual as a fingerprint. Obrig's investigation of contact lenses showed that the size of the cornea varied so much in different persons that it would be next to impossible to fit them really accurately from stock sizes. Therefore, each lens must be tailor made Exactly how this is done is shown in the accompanying series of illustrations

Without a local anaesthetic dropped into the eye it would be a difficult, painful procedure to take a cast of it



The warm wax for making the mold is poured into a little glass casting shell, ready to invert quickly over the eye, as in the picture above

First, a local anaesthetic is dropped into the eye, so that no pain will be felt during the casting.

Next, Negocoll, a hydro-colloidal plastic composition somewhat midway between a wax and a jelly, and which is liquid when warm but solid when cool, is heated to 118 degrees, Fahrenheit, and allowed to cool to 107 degrees. It is then poured into a small casting shell, and the shell is quickly inverted and gently pressed against the front of the eye as the lids are pulled out of the way.

The Negocoll cools in a few minutes to normal body temperature and solidifies, whereupon the mold may be removed from the eye.

The casting shell is pressed against the eye. In the photograph the upper eyelid is over the shell. Some of the jelly-wax trickles down the cheek

The casting shell, bearing in the wax the perfect imprint of the eye, is then placed in some convenient holder, and freshly mixed dental stone, ordinarily used for making casts of teeth for plates, is poured into it.

This substance hardens to form the cast The fifth picture shows two typical castings The one held in the hand shows only the reverse side, on which identifying marks are scratched, but the separate one shows an exact duplicate of the front surface of an eye So accurate are these castings that impressions of small blood vessels can be traced

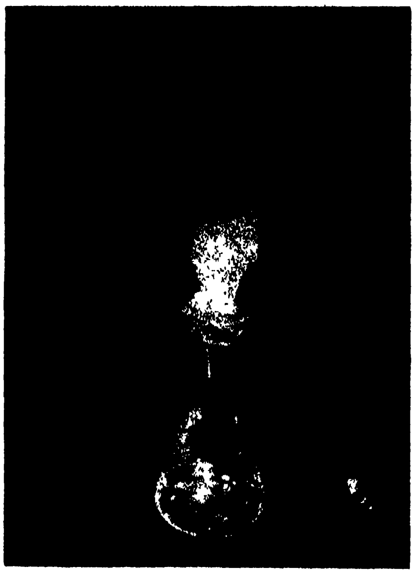
IT is from these castings that the contact lenses of clear plastic are made to fit the eye.

The final photograph shows a pair of finished contact lenses It will be noticed that the central position of each lens bulges out slightly This central position does not come into contact with the central, transparent part, or cornea, of the eye at all The outer, flanged part, rests only on the white part of the eye where it causes no pain or disturbance.

The "power," or strength, is ground on the non-contacting central portion of the lens, which will be in front of the cornea.

When the lenses are worn, the space between the central position and the cornea of the eye is filled with a special buffer solution, dropped into the hollow of the lens before it is inserted into the eye. Wearers—even highly nervous persons—learn quickly how to insert and remove contact lenses, the initial hesitancy soon giving way to a routine, as with a dental plate.

After the first fitting, contact lenses are worn for an hour or so. This period of time is gradually extended as tolerance is developed, until they



From the cast just made, which might be called a negative, a positive cast, duplicating the eye, must now in turn be made. Casting shell lies on table

are used continuously six, or eight, or even 12 hours. It is best to remove them every night and re-insert them every morning, but one young man, who did not read the instructions carefully, left his lenses in for two weeks without doing any harm to his eyes.

DESPITE all precautions taken in making the mold, it occasionally happens that the lens will touch a position of the cornea, which eventually would cause damage. Formerly, exhaustive studies with the microscope were necessary in order to rule this out. Here came another of Obrig's outstanding contributions—the use of fluorescein When invisible ultra-violet rays are thrown on fluorescein, it glows brightly in the dark, and has thus been made use of in producing spectacular effects in the theater. Obrig filled the space between the lens and the eye with fluorescein and turned on the ultra-violet radiation. If the contact lenses fitted perfectly, the entire central area glowed. If the lens touched the cornea in any area, however small, that area remained black, for the fluorescein was displaced. By grinding off a minute amount of the lens, and then retesting with fluorescein, it is possible to continue the adjustment until the fit is exact.

The "physical fit," or the actual fitting of the lens, can therefore be achieved to perfection, while the "optical fit," or the grinding on the lens of the correct strength, whether it be for cone-shaped cornea, astigmatism, near-sightedness, or far-sightedness has been done accurately for some time.

Chief among the few minor problems yet to be completely solved is the matter of the "chemical fit," for a few eyes have difficulty in using a standard buffer solution worn regularly between the lens and the cornea. But recent investigation in the shifting of the acid-alkali balance has pointed out a new approach to this, and it is likely that the small fraction of people who cannot be "chemically" fitted will be even further reduced. Though the use of this fluid complicates to a slight degree their insertion, doctors who prescribe contact lenses point out that it is because of this that these lenses, once fitted correctly, may last easily ten years or longer. For the ordinary factors which render necessary the changing of ordinary glasses every year or so, because of altering astigmatism and so on, are entirely neutralized by the "fluid lens" which naturally fills whatever irregular space is present. And thus their cost, when the period of service is considered, is not so great.

An exact cast of each eye. The one in the hand shows the back on which identifying marks are scratched. The other, lying on the table, is a front

From the molds just made, the final contact lenses are cast in plastic and finished, each as individual as a fingerprint, are each a precise fit

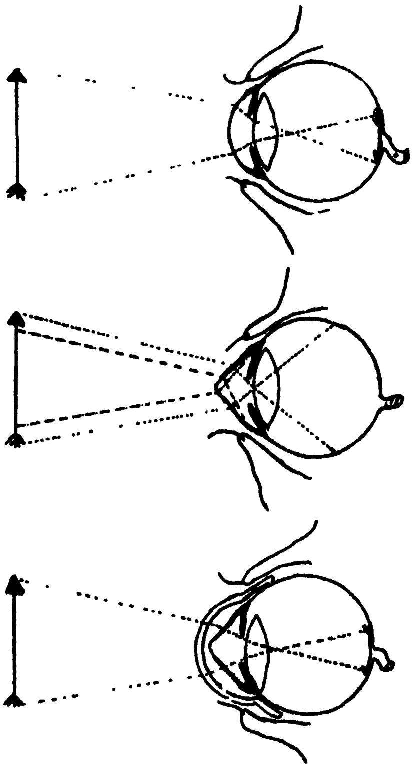
Fitted contact lenses are still quite expensive, as each pair is as individual as fingerprints. Melted down, you could buy the plastic used for only a few cents; but so highly technical is their fitting, to say nothing of the skill required of the manufacturer, that it is unlikely that they will soon be cheaper.

Contrary to a widespread belief that contact lenses were designed primarily to satisfy a desire for a more sightly substitute for spectacles, the motive for their development has been to give vision or protection to certain kinds of abnormal eyes which can be benefitted by no other means. One such example, showing how a contact lens gave good vision where there was practically none, is shown in the drawings.

The upper drawing shows a normal eye which attains perfect vision because the cornea and lens focus the rays of light from the object viewed onto the retina, from whence it goes to the brain by way of the optic nerve.

In the middle drawing is a case of keratoconus, or cone-shaped eye. Because of the cone shape, the rays of light are not focused—some do not pass through the pupil and others spread out to the edge of the pupil. All this eye can see is the difference between light and dark, and ordinary glasses will not help.

But the contact lens in the lower drawing affords normal refraction of the light rays again. As is shown, it fits against the white part of the eye, but does not touch the clear part (cornea) where it would cause discomfort. The intervening space is



A normal eye, an abnormal eye (serious case of keratoconus), and the optical effect of contact lenses: restored vision in a "hopeless" case filled with the special buffer solution regularly worn with the contact lenses. Now, since the refractive index of this fluid is almost the same as that of the fluid within the eye itself, the rays of light focused by the contact lens pass unchanged by the distorted cornea to the retina as happens in the normal eye.

There is a rather widespread belief that contact lenses are a new idea but this is by no means the case. They represent the culmination of years of hard work and investigation by a score of scientific men, most of whom approached the problem from different angles and each of whom made some real contribution to the solution.

The first scientist to propose and record such an idea was the astronomer, Sir John Herschel, who suggested in 1827 that a glass shell could be devised to fit over the eye to protect it from infection by a diseased lid Sixty years later F. E. Mueller, in Germany, made one of blown glass which successfully protected for several years the eye of a patient who was unable to close it because of cancer of the lid.

In 1888, A. Fick, also of Germany, suggested that contact lenses be used for the condition called keratoconus, or cone-shaped cornea, described above. For this the Zeiss firm made contact lenses of blown glass

In 1892 Sulzer ground some contact lenses of optical glass. They gave good vision but caused discomfort and could not be successfully worn.

In 1909 the Mueller optical firm produced contact lenses of "glass eye" glass but, among other imperfections, these contained impurities and had a very short life.

In 1920 Carl Zeiss accurately ground and polished contact lenses of chemically resistant glass, but only in one size. By continuing their research they found that varying sizes could be made. Not only could these be used for conical cornea, but also for near-sightedness, far-sightedness, and astigmatism. For the first time, contact lenses were brought within reach of the average person having a more commonly found type of defective vision. Many persons were fitted with these lenses, but to users in the United States it meant not only an exhausting sitting, requiring the insertion of dozens of lenses in the attempt to find one having the right fit, but also a long delay, since the lenses had to be shipped back to Germany one or more times to have the necessary strength ground on the lens

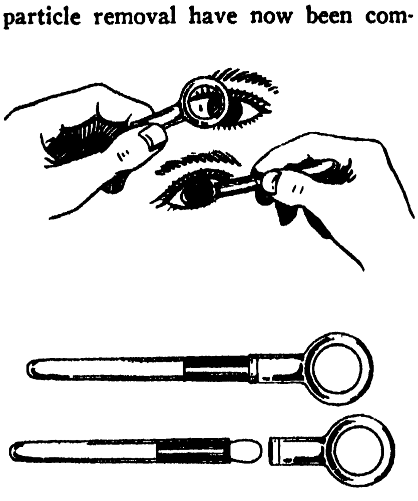
And now we have the new type of all-plastic, individually *fitted* lens, and other refinements. This is where the present story takes over—contact lenses made really wearable

• • •

PARTICLE REMOVER

Smooth, Magnetized Wire Loop For Foreign Bodies in Eye

A MAGNIFYING glass is often of great assistance in locating foreign bodies in the eye, and such bodies can be conveniently removed by means of a loop of smooth wire. These two aids in particle removal have now been combined in the Mag-Optin unit shown in the accompanying drawings. The magnifying lens is made of a plastic material and is unbreakable. The handle is also of plastic, and the wire loop is affixed to the end of it The loop itself is magnetized so as to assist in the removal of magnetic particles from the eye. Non-magnetic metallic particles, of course, are mechanically removed by the smooth wire loop



Magnifies and removes

SACCHARIN

No Harm in Ordinary Use of the Super-Sweet Substance

NOW that sugar is rationed, the thoughts of some have turned to saccharin and there are rumors that saccharin is dangerous While killjoy friends are always ready to tell us that whatever we enjoy is "dangerous," *The Journal of the American Medical Association* is no killjoy about saccharin. It states editorially:

"Sugar rationing and new emphasis on weight reduction have doubtless increased the use of saccharin for sweetening purposes. Renewed interest in the possible harmful effect of this substance is an apparent corollary. Earlier investigations of saccharin, however, have failed to reveal dangerous side-actions except from extremely large doses. Likewise the evidence does not reveal any reason why saccharin cannot be used continuously in average sweetening doses for an indefinite period. Many patients have taken saccharin for years without harmful effect."

IVORY DOME

Baldness May Be Caused by Calcification of the Skull

A NEW theory of the cause of baldness has been proposed in *The Journal of the American Medical Association*, by Dr. Frederick Hoelzel of Chicago. The cranial sutures, or little wavy joint cracks of the skull, also other skull openings, may become calcified and shut off some of the circulation to the scalp. He describes "observations which I made while serving as technician in gross anatomy.

"I then had occasion," he continues, "to remove the brains of about 80 cadavers for separate use in the neurology classes and incidentally noted a seemingly obvious relation between the blood (vessel) supply to the scalp and the quantity of hair. Baldness occurred in persons in whom calcification of the skull bones apparently had not only firmly knitted the cranial sutures but also closed or narrowed various small foramens through which blood vessels pass, most prominently in persons with a luxuriant crop of hair

"These blood vessels are mainly veins which normally communicate with the diploic veins in the spongy tissue of the skull bones but which are evidently pinched off by calcification of the foramens Various stages of this process of impairing the blood circulation of the scalp could be observed.

"This, then, not only explains why baldness occurs but also why men are more likely to become bald than women, since bone growth or calcification is generally greater in males than in females.

"Obviously 'hair tonics' or vitamins are not likely to restore a blood circulation through what has practically become 'solid ivory' Moreover, one wonders whether the promotion of a higher calcium intake among adults may not eventually increase the incidence of baldness and the sales of its vaunted remedies."

Science in the Forest

Modern Forestry Management Takes into Consideration All Phases of Wood Growing and Utilization

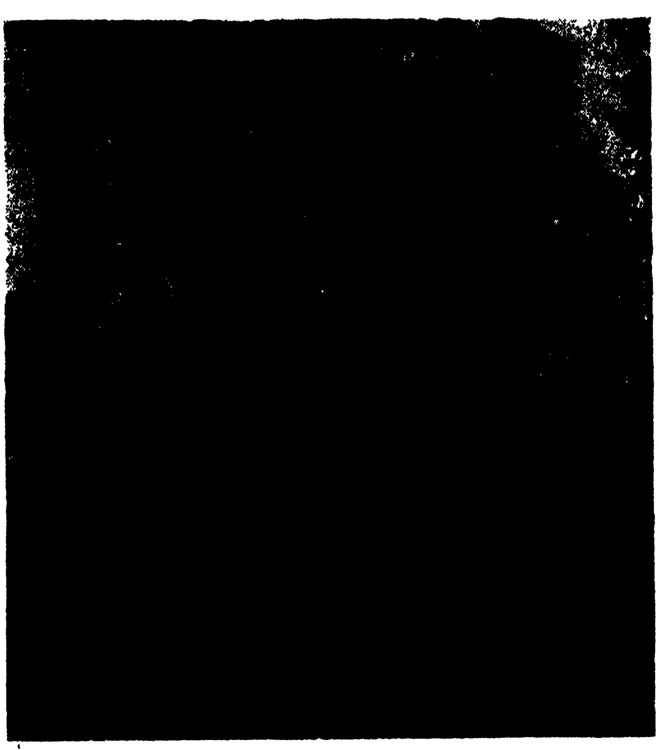
G. H. COLLINGWOOD
Chief Forester, American Forest
Products Industries, Inc.

MODERN forestry, plus more scientific utilization of wood, are insuring adequate supplies of this vital natural resource for all of America's war needs while maintaining reserves for the future. The fact that wood is as important to military effort as oil, coal, or iron ore makes this especially significant. More than that, the importance of wood is further increased because its principal components, lignin and cellulose, are the basis for increasing numbers of "ersatz" products.

Sugar, textiles, proteins, alcohol, cattle fodder, industrial chemicals, and plastics—as well as an endless number of other derivatives—can be obtained from wood. Nazi war production is backboned by wood. In this country wood contributes to the war effort by providing in whole or in part approximately 1100 items of Army and Navy use. These include ships, cantonments, pontoons, gunstocks, tools, barracks and equipment, explosives, flamethrowers, gas masks, airplanes, packing boxes and crates, paper products, and fabrics.

To supply these needs our forest products industries are being called upon to produce 38 billion board feet of finished lumber this year. In addition, wood is needed for chemical distillation, fuel, and paper pulp. This is tremendous but not disastrous when one bears in mind that timber is a growing crop—a replenishable natural resource.

Fortunately, trees are living organisms whose growth and natural capacity for reproduction may be accelerated by careful management. Trees will die, but a forest may live forever. Many timber owners of the United States, well aware of this, are engaged in a program of conservation and reforestation whose objective is to guarantee abundant supplies of this basic raw material for all time.



Because this stand of trees has been thinned, those remaining will increase in growth rate. Note low, economical stumps

This objective can be attained. Much has already been accomplished. Shortly after the turn of the century the then chief forester of the United States uttered a prediction concerning the future of our timber supply which, had it come true, would have proved dire indeed. "We have all but reached the end of these forests," he said. "We have reached the point where the growth of our forests is but one-third of the annual cut, while we have in store timber enough for only 20 or 30 years at our present rate of use." On the basis of such premises, he prophesied an inevitable "timber famine" which would affect every individual.

After more than 30 years, our annual new growth of timber amounts to over eleven billion cubic feet. This is not board feet, but in addition to fuel-wood, pulpwood, and other products which are adapted to measurement in cubic feet, it includes 32 billion board feet of saw timber. When we entered the war, this new growth, or annual crop, was approaching the point where it would balance the annual amount commercially consumed. Had the war not intervened, the new growth might have equaled or even exceeded the annual forest drain from all causes by 1945.

Commercial harvesting of trees does not account for the entire amount taken from the forests each year. Fire, insects, tree diseases, and decay take constant toll. Ceaseless war must be waged against these fruitless losses as part of the forest industries' program for forest conservation and silviculture.

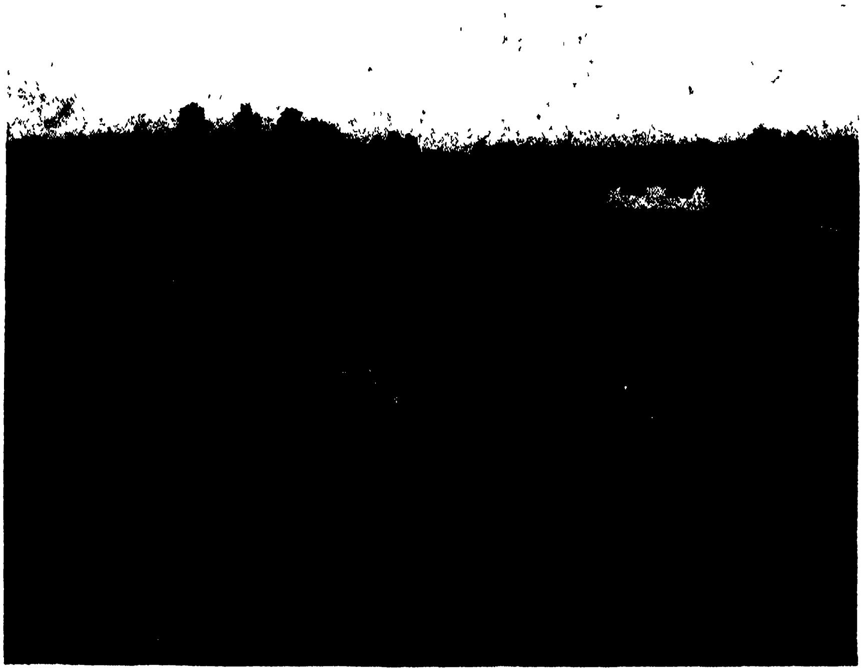
What may not be generally realized is the fact that timber is a crop just as surely as wheat or corn. Consequently, trees must be protected from fire and such "natural enemies" as insects and fungi. They should be harvested before ripeness turns into rot. There is no better way to provide for new timber crops.

FORTUNATELY, areas naturally suited to forest growth are abundant, and timber stocks are available for our needs. One third of the United States is covered with trees When the colonists arrived in America, there were some 822 million acres of forests. During the succeeding three centuries those forests have yielded over seven trillion feet of forest products for the building of the country. Despite that use, and excluding the acreage cleared to make room for cities, towns, and farms, we still have 630 million acres of forest. This includes over 460 million acres classed as commercial forest, of which nearly a quarter is virgin timber The term "virgin" applies to timber so old that it antedates the memory of man so that much of it has long since reached maturity and needs to be harvested to be saved.

America is now, and has been for 20 years, in a period of forest transition. No longer is it necessary to clear land for additional agricultural production. The present forest area of the United States is generally recognized as serving its maximum use if it continues to grow trees. This realization heralds a new era in which timber is being harvested as a crop, rather than "mined" after the destructive fashion of pioneer days.

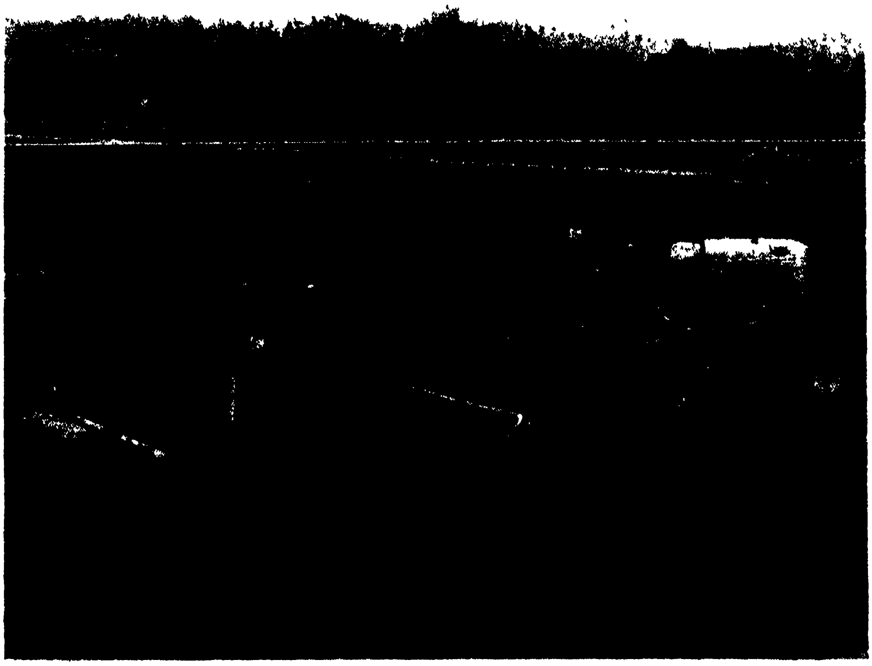
Forestry is based on the established fact that trees are living plants whose reproduction, growth, and development may be encouraged by the application of relatively simple rules. Where possible, forests are harvested in ways to assure recurring crops of new trees. Where clear-cutting is necessary, this can be done by leaving seed-trees. Individual windfirm trees with full crowns may be left at frequent intervals across the cut-over area, or groups of trees, capable of protecting one another while producing seed, may be left along water courses, on ridges, or in strips. Where practicable, selective cutting keeps the forest continually productive, at the same time avoiding abrupt changes. Forestry also calls for effective protection of the growing trees from forest fires, continuous warfare against insect pests and tree diseases, and effective use of as much of the wood as possible

Most of the badly deforested areas are the result of repeated fires which destroyed the natural sources of tree seed. Only by extensive seeding or, preferably, by planting small trees can these lands be brought back to productive forests. This calls for the maintenance of tree nurseries where seedlings or transplants can be grown preparatory to planting them on the fire-scarred stretches



Baling tree seedlings at a nursery. The forest industries of the Pacific Northwest alone are reported to have planted some 60 million seedlings during the past 10 years

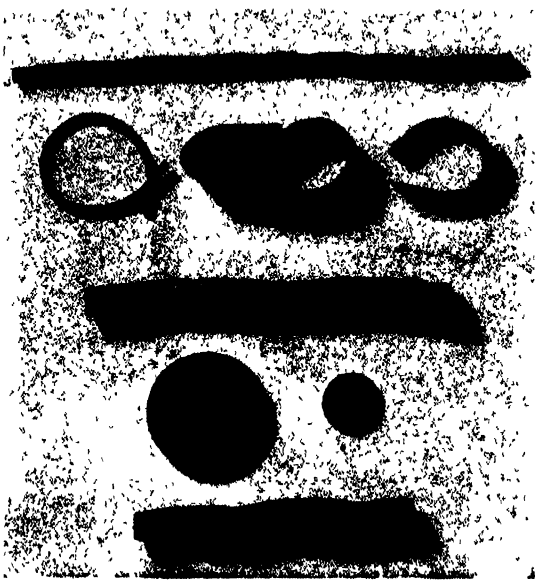
One representative example of an industry-operated nursery is the "tree factory" at Nisqually, Washington, where 25 million seedlings are being produced to reforest burned-over areas. Here are employed the latest scientific developments, including treatment of the soil with tear gas to kill weeds, selection of the seeds according to the location of their parents in order to select seedlings best suited for various soil sites and elevations, and a toughening treatment for the tender seedlings to build up their resistance and ability to survive after they are transplanted and "on their own." More than $500,000 is being spent on this nursery to supply seedlings with which to restore the forest on thousands of acres in Washington and Oregon. The Nisqually Nursery project represents real progress toward the goal of the forest industries—to keep the forest-lands continuously producing crops of trees. In the Pacific Northwest alone the forest industries have planted 60 million seedlings in the last ten years



Tear gas, introduced into the soil with this specially devised tractor-drawn plow and roller, is being used in continuing experiments to kill weeds at the Nisqually Nursery

Admittedly, planting is only feasible as a means of correcting mistakes or repairing disasters. It is neither practical nor economical to rely on artificial propagation alone to maintain forest growth and insure continuous yields of timber This can best be accomplished by working with nature to assure seed sources, to keep to a minimum the ravages of fire and disease, and to apply the principles of tree growth. Scientific forestry, therefore, comes into the picture at the very source, out in the woods where the fallers and buckers are operating.

Rules for conservative cutting vary according to the kinds and sizes of trees being harvested, the locality, and a variety of other conditions. Where trees of differing ages grow together, and especially where the forest consists of several kinds of trees, with young and old together, the generally accepted practice is to cut selectively. This term is applied to an operation where only trees over a certain minimum diameter, together with those which are defective, are harvested.



By a special treatment process it is possible to bend and twist certain woods to such shapes as these, shapes that will be permanently maintained

The smaller trees are left to make further growth and to provide seed for restocking the openings. Stands of trees that are growing too thickly may be thinned to hasten the growth of those that are left. Selective cutting is also adapted to stands which are used for more than one purpose, as in the South, where one operation may yield sawlogs, turpentine, plywood, and fuel.

Some kinds of trees demand direct sunlight in early youth, and languish in the shade. Accordingly, they often develop large areas of one-age forests. This is particularly true of Douglas fir in the Northwest where often most of the trees in a given stand are about the same age and, generally speaking, the same size. It may be advisable to clear-cut these stands and leave clumps or strips of firm-rooted, large-crowned mature trees to reseed the cut-over area. Under such conditions the seed trees may be the sources of fertile seed to cover the surrounding land for several hundred yards After the area is fully stocked with young trees, the old seed trees may be, and often are, harvested.

In this plywood testing machine, specimens are pulled apart to show relative strengths of the wood and glue. The wood must rupture before the glue

Regardless of the difference in operations, forestry aims to perpetuate the forest. At the same time, it must be accompanied by continuous efforts to protect the young, growing forest from fire.

Definitely planned cutting to assure continuous forest growth is relatively new in this country. So also are the efforts of the states, the federal government, and the timberland owners to protect all forest growth from fire. Many timbermen in the East and South, however, are harvesting third- and fourth-growth timber, whose each successive crop is the progeny of seed trees left from earlier cuts.

The expanding program of forest management for continuous growth has been popularly called "tree farming." Its practice includes larger industrial operators as well as many thousand forward-looking owners of farm woodlots. Of the nation's commercial forest area, 39 percent is held in industrially productive private ownership, 21 percent is in National Forest reserves or other forms of public ownership, and 40 percent is in farm woodlots. The Pacific Northwest holds nearly half the virgin saw-timber stand, all of which is under protection, and an increasing proportion is classed as managed "tree farms."

Since young and middle-aged trees grow most rapidly, managed cutting increases the efficiency of forest-land. In general, trees should be harvested when they reach an age when their annual growth begins to taper off. Since every tree in the forests of this country keeps its growth record in so-called "annual rings" within its trunk, it is possible to sample a few trees in any stand to determine when to harvest for maximum timber yield. In some cases the greatest annual yield is realized when relatively young, immature trees are cut. This is true of Southern pine grown for pulpwood. These trees make excellent pulp, but most of the product of Southern mills is Kraft, or heavy wrapping paper, which need not be white. This is an advantage, since the high resin content of Southern pine makes bleaching expensive. Under careful forest management Southern pines grow to a diameter of eight inches in seven years, which, although admittedly exceptional, can provide 14 or 15 full crops of pulpwood in a century. Under management and protection from fire 300 square miles of Southern pine forest can keep a 500-ton-a-day paper mill in operation forever. As against this, 2000 square miles of Northern spruce forest, not under intensive forest management, may be needed to do the same.

Where forest stands have been selectively thinned so that individual trees may receive plenty of light, second-growth pine on Southern "tree farms" are not uncommonly big enough for turpentining in 15 years. In fast-growing sections small sawlogs may be ready for harvest in 20 to 30 years, and whole forest areas under management frequently grow 300 to 400 board feet per acre per year.

The blanket on the floor, the handful of "wool," the hat, are wood products

The great stands of old, untouched timber still in the Pacific Northwest are alone sufficient to supply all the country's lumber needs for many years, were no new trees to grow. As the old trees are harvested, the new growth can meet all of the newsprint demands of the entire country year after year. This is especially true where hemlock once looked on as a "forest weed," is now used for pulpwood, and where the larger logs are in demand for airplane stock. New forest crops in this region are ready to harvest in 70 years or less.

Fire is the greatest single obstacle to forest growth. Young trees are most vulnerable to fire damage; older trees are protected to some degree by thicker, more resistant bark, and because the more inflammable foliage is higher from the ground. Destruction of young growth and seed sources renders denuded forestland incapable of unaided recovery. More than that, fire destroys much of the fertile soil humus, making difficult the establishment of "tree plantations." Most forest fires are caused by man, either from incendiary motives or because of carelessness by smokers, campers, hunters, fishermen, and picnickers. To offset this, workers in the woods are almost extravagantly careful of fire. Some might think the adjective ill-chosen, but woodsmen and foresters know that no extravagance is more unforgivable than a blaze that sweeps through the woods.

Together with insects and tree diseases, fire accounts for 15 percent of the annual use and loss of forest products, the other 85 percent being consumed by man. If the first three of these factors could be controlled, new tree growth would soon balance the needs of industry and home uses, despite the tremendous demands of the war.

Constructive cutting practices, therefore, protect seed sources and provide thorough-going fire protection, while unproductive and burned-over areas are restocked with nursery-grown seedlings. These, together with effective utilization of all harvested trees, are the basis of the "tree-farming" program which is the forest industries' assurance that American industry will not lack wood.

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How's The Weather?

Odd Weather Predictors, Some of Which Can be Shown to Have Little-Known Scientific Backgrounds

Many "signs" have been used by humans to foretell atmospheric conditions. Although a number of these have little or no value, others may be the basis of reasonably accurate predictions The following are random selections of nature's odd weather gages.

Previous injuries are often used as storm indicators. How often have we heard statements like the following· "Well, I believe it will rain. That lame foot of mine is aching."

Such previous injuries may give more trouble before or during the beginning of the storm. While prophecies based upon such pathological conditions are not always reliable, their accuracy is far greater than that of the average curbstone predictor.

There is scientific background for such forecasting. The healing of injuries is not as perfect as we may suppose. The tissues, the capillaries, and possibly the nerves heal unevenly. Since the circulation system is sensitive to air density, the capillaries may become sufficiently distended during low pressures to cause pain in varying degrees. In other words, the former wound acts as an indicator for low pressure much as a barometer does, although less perfectly. As a low barometer indicates an oncoming storm, so does the former injury.

Other ailments: People with rheumatism, arthritis, or other ailments can also predict storms for similar reasons. Neurotic people and those with poor hearts are often sensitive enough to prophesy atmospheric conditions. More often, people's dispositions are enough impaired during lows so that others may use them for living barometers. Sleep of otherwise normal humans is interfered with during periods of lowered pressure

This condition must not be confused with that of people who go to higher altitudes. The atmospheric density becomes less as one goes upward, but the aches and pains one feels during steep climbs by train or auto have nothing whatsoever to do with the weather conditions.

People who are sensitive to changes in atmospheric pressure often go to a doctor unnecessarily. The conditions which cause their discomfort are harmless and temporary. If such persons possessed a barometer and watched it carefully, they would be able to tell the serious symptoms from those due to lessened air densities. A microbarograph would be ideal, but an ordinary aneroid barometer would also be quite satisfactory.

Wind caves have the peculiar quality of acting as natural barometers. Caves with enormous capacity may have limited exits to the atmosphere. During high pressure the atmosphere will be forced into such caves. During lowered or lessened "outdoor" densities the accumulated air will blow out of the vents. Wind Cave of the Black Hills is such a cave, but there are others, like the Medicine Hole of the North Dakota Killdeer Mountains, which acts in much the same manner. Although less accurate than a barometer, due to suction of winds and perhaps other causes, the movements of air currents in caves are quite useful as weather indicators.

Wells and Springs. In late medieval times in Italy there were some wells which acted queerly. On most days they would produce water by pumping, but it was observed that on days preceding a storm they would not. The failure to yield water was used as a storm predictor by some. Others attributed magical properties to such a knowing fluid and either shunned or sought (depending on the temperament of the individual) the liquid because of its supposed supernatural properties.

However, the scientific explanation is the simple one. The valves of the pumps used at that time were often considerably above water. It would be hardly possible for pumps to operate 30 feet above the level of the liquid under the best conditions, and almost impossible under usual conditions, yet excessive pumping frequently lowered the well to this critical stage. During the low barometer such pumps tended to protect the well against excessive depletion. The well, therefore, predicted weather about as efficiently as a crude barometer.

Springs and wells sometimes become

Courtesy "Taylor-Rochester."

"milky" or cloudy before storms. In many instances these are used as local weather forecasters. This seemingly peculiar phenomenon also can be explained scientifically. All flows from underground sources dissolve some gas. Under heavy pressure more gas is dissolved than under low pressure. If the air density is high, gas does not flow or form easily on coming to the surface. If the pressure is low, however, enough tiny bubbles will form to give the water a temporary milky appearance. Often the particles of released gas will bring into the spring or well the sediments deposited during other periods. These may remain suspended and give the liquid a murky or milky appearance. Also the flow may be increased a little during such periods. The spring is therefore like a very crude barometer and, as such, can be used for forecasting purposes.

Moisture phenomena are often used for amateur forecasting. Hazy air gives evidence of the abundance of water vapor. As such, it may be a crude indicator of rain, and because aqueous gas is lighter than air, it is a crude gage of barometric pressure. The "ring" or "rings" around the moon, the halos, coronas, and similar phenomena likewise predict rain.

Human hair is sensitive to atmospheric moisture. Naturally curly hair becomes more curly when the air is damp. Artificially fashioned hair, even the press of one's woolen trousers, tends to go back to the natural state under such hygroscopic conditions. Scientists have recognized the significance of this truth in constructing one of the water-vapor testing instruments, the hair hygrometer.

Landscape features are popular as weather guides. If a mountain or butte to the west becomes unusually hazy or is obscured by a certain type of cloud, a storm will soon be upon us. But this is because weather in our latitude usually travels from the west and we are merely observing it in advance. Pikes Peak of Colorado and Crow Peak of the Northern Black Hills are examples of this type of indicators.

Rainbows in the west also fortell an oncoming rain. But they always occur in the early morning, on rain which is already falling a short distance to the west and which in all probability soon will reach us.

The foregoing indicators are of considerable scientific interest. In no case, however, are they as reliable as the devices used by the weather forecasters. If one lives in an area where such phenomena cannot be conveniently observed, it is some satisfaction to know that good instruments, intelligently used, are much better than nature's weather gages.

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FLOATING GLASS

Made By New Process, Has Many Potential Uses

A NEW type of opaque glass that floats like cork and can be used as the buoyant element in the construction of life boats, life rafts, life preservers, and pontoon bridge supports has been developed by the Pittsburgh Corning Corporation. The new product, called Foamglas, also has valuable insulating qualities. It has a weight of only ten pounds per cubic foot—one fifteenth that of ordinary glass—and is odorless, fireproof, and vermin proof.

It is now under active investigation by certain Federal government agencies as an alternate material for such critical products as cork, balsa wood, cellular rubber, and kapok, which are largely imported. Foamglas does not resemble any form of glass heretofore manufactured. It is extremely light in weight, opaque, rigid, and has a cellular structure containing a myriad of tiny air-tight cells which give it buoyancy and insulating properties.

It can be sawed or drilled with ordinary tools. Because of its closed-cell structure it will not absorb water and it will float indefinitely. It is available in slabs 12 inches by 18 inches and in thicknesses of 2 inches, 3 inches, 4½ inches, and 6 inches.

Foamglas is produced by firing ordinary glass which has been mixed with a small quantity of pure carbon. At the proper temperature the glass softens and the carbon turns into a gas which then acts upon the molten glass very much as baking powder or yeast behaves when bread is baked. By proper selection of the glass batch, the type of carbon, and by exact control over the time and temperature used, it is possible to obtain rigid vitreous slabs of Foamglas in which the cells are uniformly small in size and entirely sealed one from another.

SUNFALL

Measured by Use of New Electron Tubes

SENSITIVE new electronic "eyes" developed by Westinghouse engineers to see and record invisible ultra-violet rays in sunshine will be used to make daily measurements of "sunfall" in the United States to study its effect on the wartime health of the nation. The new sun-measuring instruments eventually will operate in 20 of the world's first solar observation posts to be set up for a nationwide ultra-violet study by the United States Weather Bureau. By recording the amount of ultra-violet which penetrates through the haze of big metropolitan centers, Weather Bureau officials believe that it may eventually be possible to forecast for several days in advance the intensity of sunfall over a city.

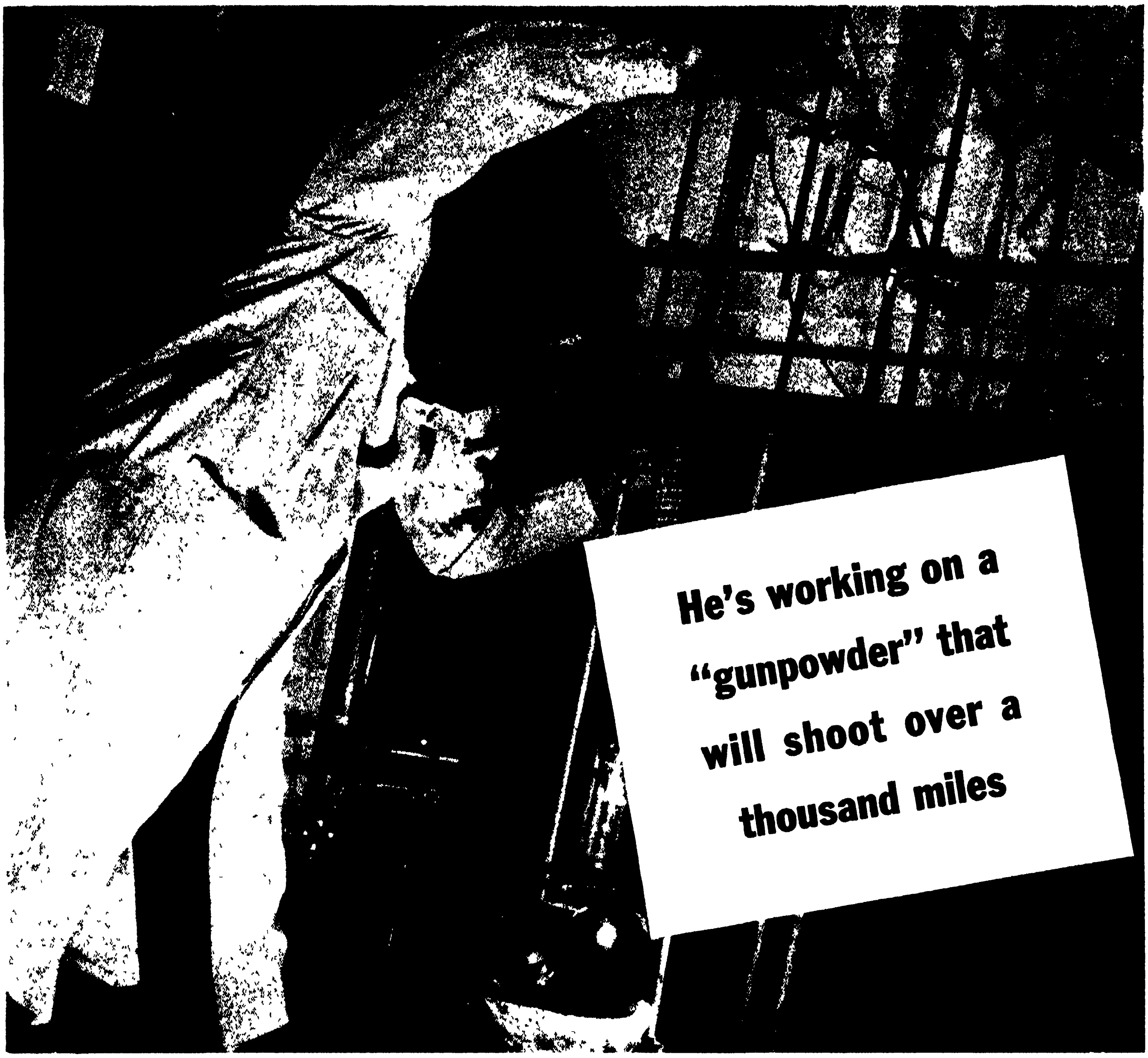
Measures sun tan rays

Development of new electronic light cells in the meters will make sunfall measurements as accurate and uniform as the familiar rainfall statistics now issued by the Weather Bureau, according to Dr. H. C. Rentschler, Director of the Westinghouse lamp research laboratories.

"Many of the effects of the sun's invisible ultra-violet rays on human health are still a scientific riddle to research men, mainly because of a need for uniform and dependable instruments to measure solar radiations," Dr. Rentschler explained. "Electronics research has now produced a tool that will make it possible to meter and standardize a unit of sunlight just as accurately as a watt of electricity or gallon of fluid.

"Sun statistics taken from various climate zones and compared with the health statistics of those zones will be one way in which research men can study the effect of ultra-violet on humans. Such studies could be aimed at determining what preventive or curative effect, if any, sunlight has on such diseases as tuberculosis and rickets and the relationship between liberal exposure to ultra-violet and general health," Dr. Rentschler said.

In appearance, the ultra-violet sun meter resembles a long, oversized


He's working on a "gunpowder" that will shoot over a thousand miles

The black powder of the American Revolution could lob a cannon ball about a mile. At the time of the First World War the normal heavy artillery range, with smokeless powder, was about twenty miles.

For this war, chemical research developed a propellant that has a range of hundreds—even thousands—of miles. Already it has carried four-thousand-pound projectiles from somewhere in England straight to the heart of German industry. It has dropped destruction on a Japanese fleet that was nearly a thousand miles from our outposts. From "Shangri La" it sent all Tokio scurrying for cover.

The new "gunpowder," which has changed the whole strategy of war, is *high-octane gasoline.*

In modern aerial war the bomb is the shell, the airplane is the cannon and high-octane aviation fuel is the propelling charge. The side which has the best aviation fuel—the one which gives the most power, the greatest range per gallon—enjoys an advantage of tremendous value.

Fortunately for the United Nations, the development of high-octane gasoline was a triumph of the American petroleum industry. Long before Pearl Harbor, U. S. petroleum chemists were seeking and finding new and better components for aviation fuels—iso-octane, Ethyl fluid and many others—developing processes and facilities for producing these aids to high-octane quality in volume. They advanced the art of refining petroleum from a simple distilling and cracking process to a science of synthesizing special chemicals—then blended these chemicals into fuels of predetermined characteristics and quality. Since Ethyl fluid plays an important part in the manufacture of high-octane fuels, Ethyl research engineers have cooperated with petroleum technologists in their search for better fuels. And because fuels and engines are inseparably related in their development, we work with engine designers in their efforts to get the most from these superior fuels. Today it is our privilege to furnish our product and devote our technical experience to the cause of American victory.

ETHYL CORPORATION
Chrysler Building, New York City
Manufacturers of Ethyl fluid, used by oil refiners to improve antiknock quality of aviation and motor gasolines.

radio tube. At the upper end of the instrument is a flat metal button about the size of a half dollar and surrounded by a circular wire electrode. The metal in its refined state is sensitive only to that portion of the ultra-violet in sunlight which produces sunburn. The sun's rays, striking the surface of the disk is a nearly perfect vacuum, cause the metal to release a stream of photoelectrons which travel to the electrode. This current is so small that it must be expressed in millionths of watts, or microwatts.

From the electrode, photoelectrons pass to a tiny condenser, actually an "electronic bucket" which stores up the energy over a period of seconds and then releases it in a single charge across an electrical circuit in the tube. Each time the condenser discharges its quota of photoelectrons, a sensitive relay "trigger" registers a sharp click which reveals that a known quantity of ultra-violet is reaching the earth. The number and frequency of clicks provide research men with the total quantity for any given period of time.

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ENGLISH RATIONING—In England during the first three months of the war 1,000,000 cars were laid up due to rationing of gasoline, the increased price of gasoline and tires, and the greatly increased taxation. The sales in July 1940 were only one-quarter of those in 1938, and purchase of new cars was thereafter forbidden.

• • •

GLASS CAMOUFLAGE

Fibers Employed As Covering for Nets

Glass, ordinarily thought of as a substance used to reveal rather than conceal, today is helping to conceal America's vital war plants against the day when they may become the target of enemy bombers.

Because they are light in weight, don't decay, are unaffected by fresh or salt water, and will not burn, fine, flexible glass fibers thinner than a human hair are being used as the covering, or garnish, for the metal-mesh camouflage nets which are employed to hide strategic war production plants and other possible bombing objectives from enemy raiders.

The glass fibers, manufactured by Owens-Corning Fiberglas Corporation, are spread over chicken wire and painted with designs that blend with the surrounding terrain, whether it be cultivated fields and orchards, or the houses and gardens of a village or suburb.

The fibers can be painted as often as necessary to keep the camouflage design in harmony with seasonal changes in the appearance of the surrounding countryside. Since the combination of metal and glass is incombustible, the nets cannot be destroyed by incendiary bombs.

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JELLY—Even though the pectin makes jelly jell, it is impossible to produce jelly without sugar. Pectin and fruit juices alone won't do it. Sugar unites the two and is the vehicle which carries flavor.

• • •

WOODEN TIRES

Being Used on Ship-Yard Trailers

Twelve blocks of hard maple per wheel, soaked in linseed oil for 24 hours and fitted as shown in two of our illustrations, are being used on tractor-drawn trailers in a shipyard of the Federal Shipbuilding and Dry Dock Company. These trailers spend most of their time moving 20-ton ship propellers, although it is reported that the wooden-tired wheels will stand up satisfactorily under a load of 50 tons.

Two views of the method of applying a new wooden tire for trailer use

The rubber tires that were replaced by these wooden blocks weighed 100 pounds each. It is stated by the shipbuilding company that the wooden replacements are good for from one to two years and probably even longer if the blocks are thoroughly boiled in paraffine before assembly.

NEW POLARIZER

Made From Materials Available in this Country

Polarization is one of the present-day fields where research and production stimulation, together with shortages of raw materials, have put the pressure on scientists and engineers to develop substitute materials which have proved to be more suitable than the products hitherto supplied. Before the war, polarizing materials manufactured depended on alkaloids such as quinine for the basic raw material which, when combined with iodine and other chemicals, produced a crystal of strong polarizing properties. But the shortage of imported quinine and cinchonidine has become acute.

Hence Alvin M. Marks, research engineer, well known for his inventions in the polarizing field, in collaboration with his brother, Mortimer Marks, was stimulated to perfect a new continuous crystalline plastic polarizing film which is made from readily available raw materials produced wholly in the United States This new polarizer is available as a film or as laminated glass, and the development assures the United States a source of supply of this vital product which is an essential part of our war machine.

Today polarizing material is used in gunsights, range finders, binoculars, telescopes, and sighting devices in general, either as a variable light control or to remove glare. Other uses are for blackout protection, navigational instruments, scientific instruments, non-glare goggles and eyeglasses, polarized illumination to produce non-glare lighting, photography and television, polariscopes, three dimensional movies or still pictures, and so on.

X-RAY

Machine Gives Radiations More Penetrating than Radium

Development of a direct current X-ray generator operating at a potential of more than 4,000,000 volts makes possible for the first time production of radiation which is more penetrating than the gamma rays of radium and which has an intensity greater than

Wanted: MORE EXECUTIVES!

To help win the war!...and the peace to follow!

Every great crisis produces new leaders. This war is no exception. It has created as great a crisis for business as for our nation, and new leaders are rising to the top every day.

Right now, companies are searching high and low for men of executive ability and training to manage the different departments in new and expanded plants. The war and its demands for production, and *more* production, has thinned the ranks of executives to the danger point. The country needs men of executive ability just as it needs production workers and men for the armed forces.

Where will it find them? Ordinarily there would be enough "officer material" right in the ranks . . . men who had been learning by experience, slowly but steadily advancing in the companies which employed them. That is one way of doing it—the hard way, the slow way. But now time is pressing. Such men are needed not two years from now, but *today* and *tomorrow!* Where will they come from? Those men will have to be trained, ***and the smart ones will train themselves—now!***

How can they do that? Through the Alexander Hamilton Institute's intensive Course of Executive Training.

This executive training, which is described in a book called "FORGING AHEAD IN BUSINESS," can help you to accomplish in months what would otherwise take years—if you could get it at all. It is valuable to men in different lines of business because it covers the fundamentals of *all* business—production, marketing, finance and accounting. It is equally effective for the college graduate or the business man who only finished grammar school.

More than 400,000 men have enrolled for this training and every day reports come in of their promotions, salary increases, new and better positions. Many of these men have become so famous that you will recognize their names instantly when you see them in this booklet.

Send for "FORGING AHEAD IN BUSINESS"

The facts about this executive training are given in the book "FORGING AHEAD IN BUSINESS." This 64-page book has inspired thousands of men. Many say it started them on the road to real business success.

A word of warning. If you are *not* interested in executive training, don't send for this book. But if you *are* interested in this way to better your position and increase your earning power, then we want you to have a copy of "FORGING AHEAD IN BUSINESS" with our compliments. Simply fill in and mail the coupon, and the book will reach you by return mail.

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that of the entire available world supply of radium. The new generator was announced in a paper presented by Dr. John G. Trump, its designer, and R. W. Cloud who described construction of the apparatus, while a paper by Dr. Richard Dresser of Boston reported the preliminary clinical observations on the use of these high voltage X-rays. The papers were presented at a meeting of the American Roentgen Ray Society.

The new generator, developed at the Massachusetts Institute of Technology, the design of which is based on the Van de Graaff type of electrostatic high-voltage machine, consists of a dome-shaped high-voltage terminal about two feet in diameter supported on a column of alternate insulating and metallic spacers. A single insulating belt 12 inches wide travels at high speed within the column and transfers an electrical charge continuously between the ground and the terminal. This assembly is mounted within a sealed metal pressure tank in order that by compression of a mixture of air and Freon gas the electrically charged belt, terminal, and column may be insulated. This tank is four and one half feet in diameter and 13 feet high.

In operation, a negative electric charge is sprayed on the insulating belt at its lower end and carried up into the high-voltage terminal, which thus acquires a negative electrical pressure in direct proportion to the stored electrical charge. The voltage may be adjusted from a few hundred thousand volts to the maximum of more than four million volts by controlling the current sprayed on the charge-conveyor belt. The X-ray tube is fixed vertically within the generator column. A metal extension of the tube passes out through the bottom of the tank and terminates in a water-cooled gold target surrounded by lead shielding and provided with beam-defining portals and shutter. The tube consists of 100 glass rings between each of which is placed a metallic accelerating and focusing electrode connected to the generator column The electrons for producing X-rays by bombardment of the gold target originate at the tungsten filament in the high-voltage terminal end of the tube and are progressively accelerated and focused as they are propelled down the tube at the gold target.

In describing the clinical uses of the highly penetrating radiation of the new generator, Dr. Dresser reported that the rays have essentially the same physical properties as the gamma rays of radium, but that their high intensity permits long treatment distances with the result that the depth dose is much greater than it has been possible to obtain in radium therapy.

Treatment with the high-voltage deeply penetrating X-rays produces no visible skin reaction. The first X-ray generator of the type just described was developed in 1937 to operate at a potential of 1,000,000 volts. A second and more compact unit operating at 1,250,000 volts was built in 1940 for the Massachusetts General Hospital where it is in operation. The latest unit, still more compact than any of its predecessors, is operating in a special laboratory at the Massachusetts Institute of Technology, where therapeutic investigations with 3,000,000 volt rays are made under the direction of Dr. Dresser. In view of the fact that clinical experimentation at high-voltages is still in a preliminary stage, Dr. Dresser made no report on the therapeutic effects of the radiation.

D.C. generator and its pressure tank

NEW RUBBER

Ready to be Put to Work When Needed

A NEW and purer form of natural rubber was described in a paper delivered by Dr. John McGavack of United States Rubber Company at a recent meeting of American Chemical Society. The new rubber is called USF-rubber and is a new crude of improved properties, according to Dr. McGavack. It was designed to satisfy the demands expressed by the consumers of the crude rubber. Its points of superiority include a greater uniformity for easier processing; softness, requiring less power in milling; greater resistance to flex-cracking; good color; and cleanliness and purity of a high order.

The process for preparing the new USF-rubber has three main steps: First, dirt is removed from the preserved latex by a sedimentation method. The latex is then blended in large storage tanks to obtain and maintain a uniform quality of latex with a definite proportion of total solids. Finally, the rubber content of the latex is flocculated in small particles by a new technique instead of being coagulated by acid in a larger mass. In the flocculated form the rubber particles are themselves purer and may more easily be washed free of soluble impurities.

"It is unfortunate that this development which required so many years of research cannot immediately be put at the disposal of American industry," Dr. McGavack stated. "However, we now have the process and are ready to put it to work wherever needed, in plantations of the west now and later in the plantations of the far east when they have been recovered."

MILITARY MOVIES

Now Being Made With Finest Equipment

THE Air Corps movie-makers "are there with their cameras" at every important maneuver, and they co-operate with the newsreel cameramen in making Army aerial subjects. They also co-operate with major production companies in Hollywood, in technical advice on military subjects.

The big fireproof film library at Wright Field contains motion-picture records of Air Corps maneuvers and special events dating back to remarkably clear, if somewhat jerky, motion pictures of the tests at Fort Myer, Virginia, of the first Army airplane purchased from the Wright brothers in 1909.

Improved sound recordings are being obtained through use of recently installed sound equipment said to be unequaled between New York and Hollywood. The equipment mixes sounds from four separate sound tracks The commentator talks into a microphone in a soundproof recording room, while separate sound tracks are made for background effects, and the tracks are blended with proper modulations to get the finished film sound track.

Wright Field Aerial and Movie Laboratories are equipped with newest-type processing equipment, and the movie laboratory processes all motion pictures shot at Wright Field.

Technical motion pictures produced by the Air Corps Motion-Picture Laboratory for Air Corps instruction are produced by Hollywood-trained personnel. An animation studio keeps a staff of artists busy making pictures for animated cartoon sequences in the technical films. Animation has been used for years by the Air Corps in showing technical procedures, because through its use it is possible to point out precisely the essential details in a new piece of equipment without the nonessentials.—*Kodak Magazine.*

SUB LINER

Used in Battery Rooms to Prevent Corrosion

A LINING for the battery rooms of submarines is being produced on equipment which heretofore has been used in production of Goodyear's Plioweld, an interior surface for storage tanks and similar items.

On submarines, the walls and floors of the battery room are lined with rubber or composition sheeting to protect the steel walls from corrosion by escaping battery fluid and fumes. Sometimes, Goodyear officials explain, fluid escapes from the batteries as a submarine lurches, lists, or dives at sharp angles. With the new wall protection, the fluid merely flows down the sides of the battery room to be collected in special disposal equipment.

The lining is usually installed to a quarter-inch thickness over each battery room wall and floor. It is applied in two layers, each about an eighth of an inch thick, and is cemented to the submarine battery-room walls.

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MINT—There has recently been more than a 20 percent increase in peppermint acreage in Indiana and Michigan, to provide for at least part of the 400,000 pounds of menthol which formerly were imported from China and Japan.

• • •

FERTILIZER

War Should Assure Ample Nitrogen Supply

THE more recent increases in domestic capacity for synthetic manufacture of nitrogen should guarantee plenty of that product for fertilizers and every other conceivable agricultural and industrial use when the war ends, says a recent issue of the Du Pont "Agricultural News Letter."

American farmers annually require commercial fertilizers carrying enough nitrogen to supply the explosives requirements of around eight million 24-foot torpedoes or ten million 600-pound bombs.

Every time a 16-inch gun is fired, 120 pounds of nitrogen goes back into the air from whence it came. This means that the nitrogen needed annually by our farmers, along with such other plant-food elements as phosphorus and potash, to grow the food, feed, and fiber demanded of them, would, if converted to explosives, be sufficient for well over seven million 16-inch shells.

In 1910 American farmers used less than one-third as much fertilizer nitrogen as they require today. The increase from 260 million pounds in 1910 has been rapid and steady: 404 million pounds in 1920; 694 million in 1930; and 866 million in 1937, the last year a complete survey was made.

If all the nitrogen now needed annually on American farms had to be supplied by imported nitrate of soda, as was largely the case during World War I, it is conservatively estimated that American farmers would require more than 2,700,000 tons of nitrate of soda during the current year.

At the outbreak of World War I, the United States did not have a single manufacturing plant to extract nitrogen from the air. However, since then the chemical industry has developed nitrogen fixation plants. No longer are we almost wholly dependent on foreign sources or on the high-

THE ARMY-NAVY "E" Flag awarded to Bausch & Lomb recently for continuous achievement in production for Victory is the third in a series of "E" awards Previous awards included the original Navy "E" and the All-Navy "E" Burgee with star.

"Eyes Right" Has Never Meant So Much To America

EVERY job in Production for Victory calls for top visual efficiency. This means that eyes must function unfailingly and unflinchingly—at lathe, bench and on assembly line, in research and control laboratory, over drafting board and foundry flask.

Upon the skill and training of the nation's thousands of eyesight specialists rests the responsibility of forestalling eyestrain as an unconscious saboteur.

As a maker of ophthalmic products—the instruments used in the scientific examination of the human eye, the spectacle lenses and frames which these specialists use—Bausch & Lomb has an important part in America's war effort.

In the development and manufacture of actual fighting equipment, such as rangefinders, aerial height finders, binoculars, aerial map-making equipment, Bausch & Lomb is serving the Armed Forces directly. At the same time, Bausch & Lomb is providing the metallographic equipment, the microscopes, spectrographs, contour measuring projectors, optical glass and special instruments required by other manufacturers in filling military needs.

BAUSCH & LOMB
OPTICAL COMPANY • ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION

priced domestic organics of vegetable and animal origin for nitrogen. However, these sources, plus domestic sulfate of ammonia, continue to constitute the current wartime nitrogen-carrying materials allocated to fertilizer use. All synthetic nitrogen is being used for purposes other than fertilizer.

If it were not for the greatly expanded domestic synthetic nitrogen capacity, imports of nitrates would be utterly inadequate for our current needs. In fact, after combining both domestic and imported sources of nitrogen allocated to fertilizers, the manufacturers in that industry face some shortage for the coming season.

Old-fashioned organics, one of the important sources of fertilizer nitrogen at this time, include the vegetable and animal proteins such as oil-seed meals, dried blood, animal tankage, and fish products. However, the trend before the present war was definitely away from these organics and toward increased use of the newer synthetic organics and inorganics. There is every indication that this trend will continue after the war.

Imported nitrate of soda was the only important source of inorganic nitrogen up to and including 1900. Beginning with 1910, ammonium salts, chiefly from by-product coke ovens, also became an important source of fertilizer nitrogen, nearly always exceeding the tonnage of nitrate nitrogen.

As recently as 1925, not a pound of liquid ammonia was used in fertilizers manufactured in the United States but, as the result of practical application of the findings of research, more than one fourth of the nitrogen used in mixed fertilizers in this country at the outbreak of the present war was supplied by various kinds of ammoniating liquors. These give promise of playing an even greater role in fertilizer production after the war

• • •

WOOD LIFE—For every 1000 board feet of lumber treated with effective wood preservatives, an equal amount of wood products is saved for war use when the treatment given doubles the service life of the treated product.

• • •

BLACKOUT TAPE

With Adhesive Back and Phosphorescent Front

A PHOSPHORESCENT tape available in one yard rolls, one inch in width, has an adhesive back for application to surfaces surrounding openings, obstructions, and so forth. This new tape, made available by the General Luminescent Corporation, will glow in the dark for a period of eight to twelve hours after it has been activated.

ICE INDICATOR

Removes One Worry from Pilot's Mind

A NEW electronic device which signals and measures ice forming on airplanes in flight, and automatically operates the plane's de-icers, should go a long ways toward improving the efficiency of Allied bombing planes. Developed at the instigation of commercial airlines and the United States Army Air Corps, the instrument is the result of protracted research in laboratories of the Minneapolis-Honeywell Regulator Company and in flight tests over the worst icing territory in the United States.

Ice indicator in the laboratory

According to the M-H president, the need for accurate measurement of the accumulation of ice on plane wing surfaces has been acute since winter flying became mechanically possible. De-icing equipment is now standard on commercial airlines and most long-range military planes, but to operate at maximum efficiency, the de-icer must be turned on when the ice can best be cracked off.

"The 'Ice Indicator' provides the pilot with information on the thickness and rate of accumulation of ice on exposed plane surfaces," he stated. "For the first time in flying history de-icing equipment can now be turned on at the exact moment it becomes most efficient."

The indicator itself is composed of three separate units and utilizes principles of electricity for its operation. A "pick-up plate" or sensing element is mounted on wing or plane surface where ice accretion is to be measured. This plate, which is very small, is set flush with the plane so as not to disturb the air flow. It contains parts which actuate the mechanism by noting the accumulation of ice. The plate is connected to an amplifier inside the wing, which in turn is connected to a power supply unit. The latter does the actual work of turning on the de-icers and registering accumulation on an instrument board meter. The entire indicator weighs under five pounds.

MELAMINE AGAIN

For Buttons and High Wet-Strength Paper

TWO new applications of melamine resins for widely different purposes were recently announced by American Cyanamid Company. Buttons molded of melamine resin plastic have withstood the gruelling tests prescribed by the Quartermaster Corps for use on cotton garments, heretofore met only by buttons machined from pearl and from imported vegetable ivory; papers treated with melamine resins have high strength when wet and at the same time have substantially increased resistance to folding.

Melamine resin plastic is the only synthetic material unaffected by the stringent tests of laundering, ironing, fading, decontamination, and impregnation imposed by the Army on buttons for cotton underwear and similar items of issued apparel subjected to the most severe conditions in service. Buttons of other synthetic plastics have been accepted for other garments issued to our armed forces, but now melamine resin plastic joins more expensive fresh water pearl and imported vegetable ivory for making buttons to meet the most severe army service. Because buttons can be molded of synthetic resins without machining, their cost is materially reduced.

Paper retains strength when wet

Melamine resin also is the basis of a new treatment for paper pulp that imparts extraordinary wet strength to the sheet made from it and at the same time increases the resistance of the sheet to folding. Previous methods of raising the wet strength of paper have required special equipment to treat the sheet after it is formed, and the treated sheet has been characterized by lowered resistance to folding. The effect of older treatments has diminished on prolonged storage under conditions of high humidity. The new treatment is applied to the paper pulp before the sheet is formed, requiring no additional special equipment beyond that usual in every paper mill The fold resistance of the sheet made of pulp treated by the new method is approximately doubled and no diminution in wet strength or fold resistance occurs on prolonged storage even under unfavorable conditions

High wet-strength paper, valuable for paper towels, vegetable bags and wrappings, corrugated boxes, and similar services where moist materials are handled, is especially important now in view of the widening use of paper to replace other wrapping materials now scarce.

Another type of high wet-strength paper is a recently announced product of Brown Company Known as Aqualized paper, this new material is being tested as a substitute for cloth and burlap.

By means of an exclusive process, it is reported the individual cellulose fibres in Aqualized paper are effectively interlocked and fastened, thus giving an inherent wet strength all the way through the sheet, independent of any coating or any sizing. This paper can be made in various types, some of them highly absorbent and some of them so fabricated as to repel water

This new paper lends itself to such unusual uses as for clothing, Army tents, sand bags, and so on It is also being experimented with in the food field where it is being used for potato bags, crate liners, locker bags for frozen foods, and so forth.

MERCURY "BOMBS"

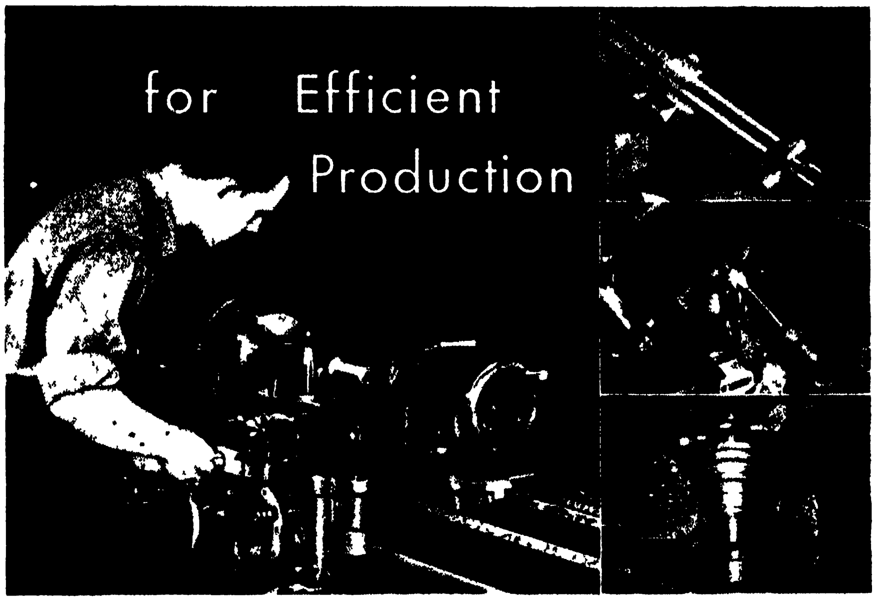
Save Precious Metal in Fluorescent Lamps

How Yankee ingenuity is stretching the nation's stocks of critical materials was illustrated recently by the announcement that Hygrade Sylvania Corporation engineers have cut the amount of mercury used in the manufacture of fluorescent lamps by approximately 50 percent in a process which has the double-barreled effect of saving mercury and of producing improved lamp performance as well.

Basis of this process is a mercury "bomb" which is exploded in the interior of the lamp during manufacture, ejecting the exact amount of mercury needed, and eliminating the wastage resulting from previous methods.

Mercury, high on the list of critical materials, is essential to the operation of a fluorescent lamp, because fluorescent light is caused by the action on fluorescent materials of ultra-violet rays emitted by electrically excited mercury atoms. Seventy percent of the world's mercury is produced in Spain and Italy, supply sources now closed to the United Nations. The United States produces about half of the remainder, but even in normal times has been forced to import substantial quantities of the metal. The loss of foreign sources skyrocketed the price from $84 a flask in August, 1939, to $202.50 in January of this year. Marginal mines were brought back into production under this favorable price situation, resulting in a 16 percent increase of production, but this has been insufficient to meet the swelling demands of wartime industry, even with the addition of almost all of the Mexican output, which heretofore had been exported to Japan. Stocks dwindled to 12,000 flasks in late 1941

Under the old method of manufacturing fluorescent tubes, a mercury dispensing device dropped free mercury into the lamp during the exhaust process. It was done automatically, but the process had many drawbacks. First, there was an unavoidable waste of mercury; second, the mercury and the dispensing parts had a tendency to become contaminated, causing further waste; third, and most important, it was impossible to maintain the exactitude necessary for best lamp performance. Some lamps received too much mercury, which resulted in heavy streaks, shadows, and dark end-discoloration in the lamps under operating



SOUTH BEND LATHES

Equally efficient on precision toolroom work or close tolerance manufacturing operations, South Bend Lathes will help solve your production problems. Substantial savings in capital investment, power consumption, floor space, and labor costs have resulted from their installation. They will give you the same efficient, trouble-free service that they are giving some of the largest war industries.

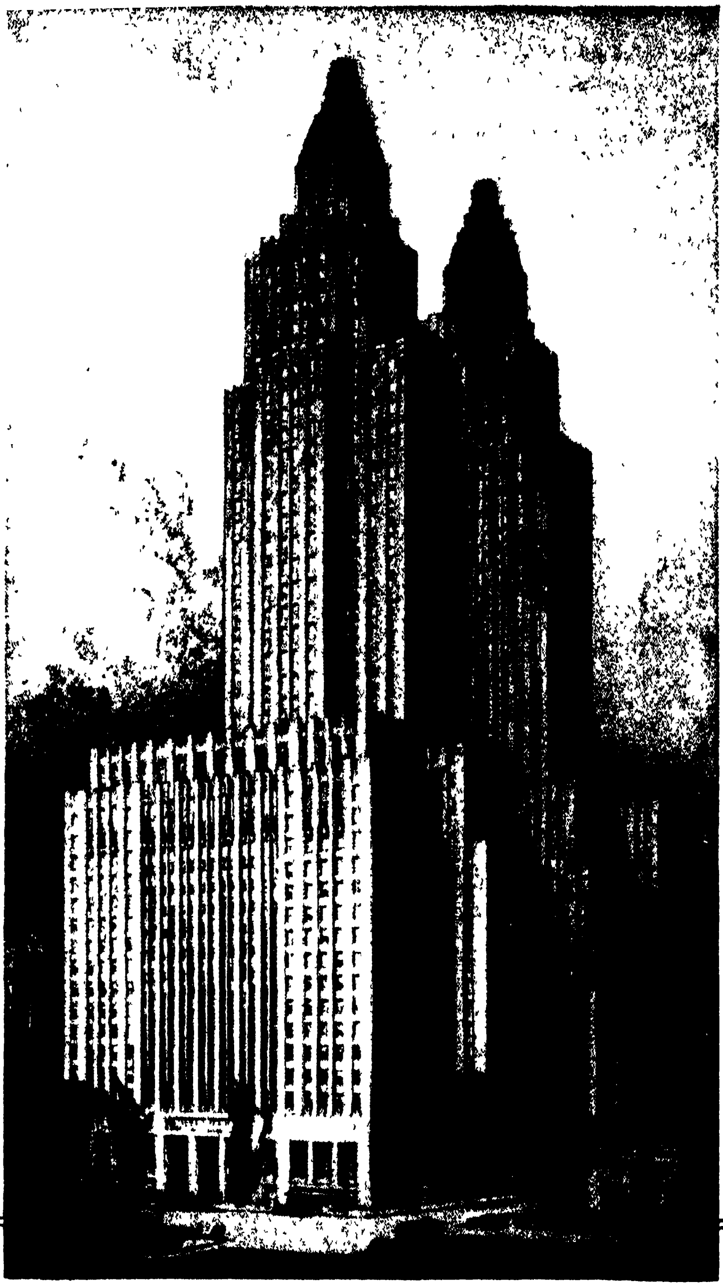
Many features contribute to the efficiency of South Bend Lathes. A wide range of spindle speeds permits maximum cutting tool efficiency. Smooth, vibration free operation permits machining work with such precision that subsequent finishing operations can often be eliminated. A convenient arrangement of controls makes for an ease of operation which reduces fatigue and lowers the probability of errors.

Made in a wide range of sizes and types, there is a South Bend Lathe that will efficiently handle almost any class of lathe work. Write for catalog and name of our nearest dealer.

"HOW TO RUN A LATHE"

A practical reference book on the operation and care of metal working lathes. Widely used for training apprentices, new operators and students. Contains 128 pages, 5½" x 8", over 365 illustrations. Price 25 cents, postpaid.

SOUTH BEND LATHE WORKS
LATHE BUILDERS FOR [illegible] YEARS
SOUTH BEND, INDIANA, U. S. A.



Smoothly geared to duration living

A home, a headquarters, a stopping-off place ...The Waldorf-Astoria serves duration living needs efficiently, economically...graciously.

THE
WALDORF-ASTORIA
PARK AVENUE, 49TH TO 50TH ST., NEW YORK

conditions. Some received too little, which makes the lamp a "slumper," or one that fades out after a few hours of burning. Thus the percentage of rejects was unnecessarily high, and it was almost impossible to reclaim the mercury in the rejects.

The new "bomb" process "wraps up" the exact amount of mercury needed for the lamp, down to the last milligram, in a tiny metal tube affixed to a support lead of one cathode. When the current is first turned on in the lamp, during the exhaust process, the heat expands the mercury and the tubing "explodes," releasing the free mercury.

Since the tubing length can contain no more than the exact amount, an oversupply of mercury is impossible, and a simple selector device removes from the production line any "bomb" with an insufficient load.

DIESEL NOZZLES

Now Tested for Accurate Delivery of Oil

A TINY injection spray nozzle, smaller than the tip of the little finger is literally the heart of a Diesel engine; the minute holes in the nozzle must be drilled at precisely the same angle to assure uniform injection of fuel. If such uniformity of injection is not obtained, the Diesel cannot operate at its peak efficiency.

Test tubes receive the oil

These injection spray nozzles employ a ring of holes ranging in number from six to ten, each hole being drilled individually to a diameter as small as 0.008 of an inch. The operation of these holes is similar to that of an atomizer; the smaller the holes, the finer the spray and the more efficiently the oil burns.

The early Diesel engines used compressed air to blow the fuel oil into the cylinders. Then came mechanical or airless injection. Still later came the development, by the Cooper-Bessemer

Corporation, of the pressure relief type of fuel injection which, in contrast with the constant pressure or mechanical injection system, might be more accurately referred to as a "controlled pressure" system.

For testing the fuel nozzles used in the Cooper-Bessemer engines, a device has been developed to check the accuracy of the tiny holes. During the test, as shown in one of our illustrations, individual nozzles are fitted into an arm overhanging a tank. Around the walls of the tank are placed a number of test tubes, the number corresponding to the number of holes in the nozzles to be tested. When oil is forced under pressure through the test nozzle, each tiny stream of oil must strike the mouth of its particular test-tube receiver accurately, and deliver the correct amount of oil in a specified time. Failure to do this results in rejection.

• • •

SUGAR—The first successful American sugar beet factory was established in Alvarado, California, in 1879. Nine years later, the second successfully operated beet sugar factory was built, which in that year, manufactured 1000 tons of sugar. Today California leads in the production of beet sugar. In 1941 the state produced 6,182,431 hundred-pound bags of beet sugar.

• • •

SOUND-PROOF

Panels Can be Added to Old Telephone Booths

By placing in old telephone booths a set of newly developed acoustic panels, the old booth becomes sound proof. With the panels in place the old door can be removed, as it is no longer a necessary part of the enclosure. The acoustic panels, manufactured by the

Panels that sound-proof

IMMEDIATE DELIVERY

LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS

	Inlet	Outlet	Price	With A. C. motor
No. 1 Centrifugal	¼"	½"	$ 6.50	$25.00
No. 4 "	¾"	½"	12.50	32.00
No. 8 "	1¼"	1 "	16.50	35.00

← GEAR

No. 1½	Gear	½"	Price	$ 9.00	With A.C. motor	$25.00
No. 2	"	¼"	"	10 00	" " "	27.50
No. 3	"	⅜"	"	11.50	" " "	28.50
No. 4	"	½"	"	12.50	" " "	32.00
No. 7	"	¾"	"	15.00	" " "	37.50
No. 9	"	1 "	"	16.50	" " "	40.50
No. 11	"	1¼"	"	48.50	" " "	on request

HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

Models D H G ¼

12" x 24" tank A C. 110 or 220 v. 60 cycle $57.50

16" x 30" tank A.C. 110 or 220 v. 60 cycle $64.50

Large stock of air compressors, ¼ H.P. to 20 H P A C. and D C., all voltages, 1 to 120 C F M. displacement, built for all requirements Additional data on request.

Synchronous Motors

New Emerson 100th H P., 900 R P M 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount, no base. Has many applications. $7.50

Small Piston Type Air Pump

Can be used for all purposes where low pressure air is required. Develops 1/3 cu. ft. of air at 15 lbs pressure. Suitable for aquariums Takes care of 6 to 8 tanks. Piston type, all brass cylinder. Belt driven. Universal AC-DC motor. Mounted on neat base. Complete. $7.95

General Electric Immersion Heaters

Suitable for heating liquids tanks, kettles, etc (1 KW raises temperature 100° F 3 gallons per hour) Fitted for 1½" iron pipe thread Can be used as 110, 220 volt or 3 heat 110 volt.

600 Watt....... $7.50 1200 Watt ... $10.50
750 " .... 7.50 2000 " .. 12 50
3000 Watt .. $15.00

MAGNETIC GAS VALVES

All sizes in stock; Prices on request

EXHAUST FANS, BUCKET BLADES

General Electric A.C. 110 volt motors.

	R P M	cu ft per min	Price
9"	1550	550	$12 00
10"	1500	550	13.50
12"	1750	800	18 00
16"	1750	1800	21 00
16"	1140	1650	27.50
18"	1750	2500	22.50
18"	1140	2100	32.00
20"	1140	2800	36 00
24"	1140	4000	42.00
24"	850	3800	45.00

Other voltages & frequencies available at slightly higher prices

DURAKOOL MERCURY SWITCHES

This metal mercury switch overcomes faults of usual mercury switches May be turned a full 360°. Has thousands of known applications from tiny lab instruments to gigantic power controls.

1 Amp. ... $1.10 20 Amp. $3.15
3 Amp. ..... 1.65 35 Amp. 5.50
5 Amp. .... 1.65 65 Amp. 11.00
10 Amp ... 2.00 200 Amp. 50.00

HEAT REGULATOR OUTFIT

Complete with Accessories! $21

GEH Economy Special! —The finest two-piece outfit on the market. Consists of an all electric Minneapolis Control Motor and a General Electric Thermostat. Motor is operated off your nearest light socket and has a built-in transformer supplying low voltage to the room thermostat. The thermostat is adjustable from 50° to 80°.

Easily installed on any type furnace.

FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H P	R P M	CU FT MIN	INLET	OUTLET	PRICE
0	1/20	1750	160	4½"	3¾"	$22 00
0½	⅙	1750	350	6½"	3¾"	25 00
1	1/6	1750	535	6 "	4½"	30 00
1¼	¼	1750	950	7½"	6 "	37 50
1½	½	1750	1900	9½"	7 "	75.00

PRICES QUOTED ARE FOR A C 110 V 60 CYCLES ONLY. OTHER VOLTAGES ON REQUEST

PIONEER AIR COMPRESSOR CO., Inc.
120-s CHAMBERS ST. NEW YORK CITY, N. Y.

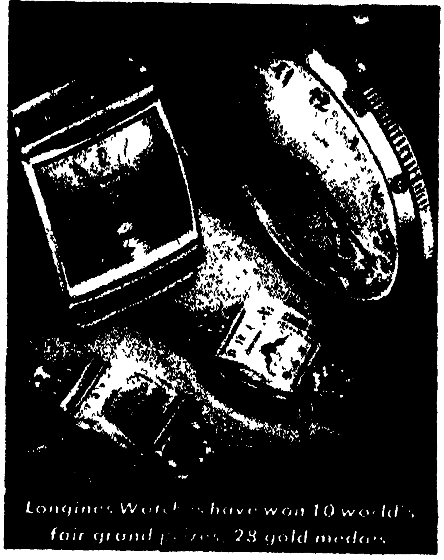
A Longines Watch for a lady is much more than a charming jewel like ornament. Within the beautifully wrought case is the Longines "Observatory Movement*", a work of incredible precision, and unbelievable accuracy and dependability considering its tiny size. The photos of the Longines Watch and movement above are both greatly enlarged. The watch is one of several in the smart round design.

Longines

THE WORLD'S MOST HONORED WATCH

The established prestige of Longines Watches has resulted in a demand today greater than necessarily restricted production. Your Longines jeweler will show you the Longines Watches that are available, and all have the dependable Longines "Observatory Movement." Longines Watches have won ten world's fair grand prizes, 28 gold medals and more honors for accuracy than any other timepiece. See also the Wittnauer watch, a companion line outstanding for value at a moderate price—product of Longines-Wittnauer Watch Co., New York, Montreal, Geneva.*

*Trade Mark Registered U. S. Pat. Off.


Longines Watches have won 10 world's fair grand prizes, 28 gold medals

Burgess Battery Company, are made of reinforced birch plywood filled with a blanket of sound absorbing material, the resulting cellular design giving an adequate sound absorbing effect. The outer surface of the panels can be finished by any conventional method.

PINEAPPLE ENZYME

Can be Used to Make Tough Meats Tender

BROMELIN, an enzyme which, like certain other members of this group, has the property of breaking down meat protein and thus making tough cuts more tender, has been successfully isolated from the peels and cores of pineapples. The technique is said to consist of pressing the juice from the peels and cores at a stage of manufacture at which the juice is of little commercial value to the canner. The bromelin is precipitated from the juice by the addition of ethanol, which can be recovered for use with fresh batches of juice.

DEHYDRATED VEGETABLES

High in Vitamins, Call For Proper Packaging

WHETHER they are being produced for soldiers and sailors overseas, for our Lease-Lend allies, or for our own dinner tables, scientifically dehydrated fruits and vegetables are "delivering the vitamins." According to laboratory technicians, the nutritive value of these space-saving products may be higher for this year's crop than ever before in the industry's history.

As in the case of canned, frozen, or fresh food, vitamin content of dehydrated vegetables depends to a great extent upon the original content and freshness of the raw foodstuffs Modern dehydrators partly solve this problem by locating their plants in the heart of the growing areas, one of the largest, in California, being within two hundred feet of its own fields.

Optimum vitamin contents of eight typical vegetables have been released by the United States Department of Agriculture, subject to unavoidable variations in the raw stock and other conditions. Arranged in the accompanying table, the figures show vitamin contents found in each 100 grams of dehydrated foods.

The packaging of dehydrated vegetables is an important factor in preserving their maximum nutritive value and palatability and is one of the important wartime projects under way in the laboratories at the New York State Experiment Station at Geneva.

Paper containers of all kinds, cardboard, parchment, foils, waxed linings, cellophane, flexible plastics, and a score of other materials are now under test by the Station scientists. Packages that may meet the necessary requirements for domestic markets may be entirely unsuited for Lease-Lend shipments and for use by combat troops, it is pointed out, because these last two categories require that the package be war-gas proof in addition to the usual requirements.

Different vegetables also present different problems when it comes to packaging. Dehydrated carrots, for example, an important source of vitamin A, deteriorate rapidly and lose color, thus greatly lowering their nutritive value unless the product is packaged under certain conditions. One of the requirements for dehydrated carrots is that the air in the container be replaced with some inert gas, such as carbon dioxide or nitrogen. The Station scientists are carrying on tests with inner liners for packaging carrots. The liners are partially sealed and then the air replaced with carbon dioxide before the final seal is made.

As a final check both of the packaging materials and the packaging processes, the various types of packages under test are being stored in a room maintained as near tropical conditions as to temperature and humidity as possible. After several months' storage under these conditions, the packages will be opened and the contents subjected to various tests, including a taste test, to determine the effect of the packaging and storing on the nutritive value and palatability of the dehydrated products.

	Pro-vitamin A (carotene) milligrams	Vitamin B_1 (thiamin) micrograms	Vitamin B_2 (riboflavin) micrograms	Vitamin C (ascorbic acid) milligrams
Beets	—	40	350	25
Carrots	90	300	300	20
Spinach	40	750	1150	150
Kale	16	500	900	300
Mustard Greens	50	—	—	400
Swiss Chard	3	550	1120	125
Sweet Potatoes	5	200	320	35
White Potatoes	—	425	250	25

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

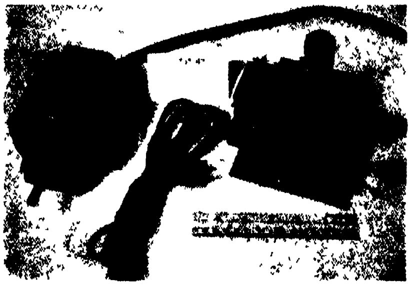
ELECTRONIC CONTROL

For Induction Motors, Operates on Micro-Watts

The direction of rotation of ordinary single-phase induction motors can be quickly and accurately controlled by means of electric circuits of negligible power and without the use of mechanical or moving contacts of any type through the use of a newly developed electronic control shown in one of our illustrations.

In the photograph an arrow points to the two control terminals, which are to be connected to any suitable control circuit. The control power in this circuit is of the low order of 100 micro-watts.

In the setup shown, the 1/50 horsepower motor weighs about 5½ pounds; the electronic control weighs about 2¾ pounds, or a weight ratio of two to one. The control, developed by W. C. Robinette, uses two receiving type vacuum tubes of less than one watt rating each.



Motor and electronic control

This electronic control of motor rotation is applicable to a number of industrial operations where a relatively small movement of some mechanism or other moving part is to be applied to governing the direction and speed of a motor.

REDUCTION DRIVE

Adapts Motors to Slow-Speed Machines

A compact speed reduction unit that mounts on the shaft extension of a machine to be driven is now available in five standard sizes from ½ to 25 horsepower. The unit, made by The American Pulley Company, is attached to the shaft by means of a keyed bushing and is prevented from rotating by a torque arm which is bolted to the case and to a rigid support.

Within the case of the unit, shown in one of our illustrations, is a compact yet efficient gear train which provides a standard fixed speed ratio of 13 to 1. Any differences between this ratio and the desired total ratio can be accomplished by the proper choice of standard pulleys for the primary belt drive. Also, there are available adjustable diameter pulleys which can be employed where operations require frequent or rapid speed changes.

Reduction drive is back of pulley

HORSESHOE MAGNET

Speeds Up Welding by Eliminating Arc Blow

A wartime version of the old fashioned horseshoe magnet has pointed the way to possible major gains in welding steel plates for war machines

Savings in man-hours, as well as improvement in quality of welds, are expected to result when the specially designed "magnetic shunt," as the device is called, goes into heavy duty on Army and Navy ordnance materials. The magnetic shunt was used in a series of tests to tame magnetic arc blow, traditional pest of the electric welder.

Magnetic arc blow, according to Charles H. Jennings and Alfred B. White, Westinghouse research engineers, is a tendency often developed by electric welding arcs to be deflected from their course, and thus produce slow, irregular, and frequently inferior

1917 WAR
RUN BY
TELEPHONE

1942 WAR
RUN BY
RADIO

For Instance...

. . . during the Dieppe raid, Gen. Roberts commanded from headquarters on a destroyer. . . . along a nine-mile front wireless [radio] messages could be heard coming in . . . . . . a smoke shield was ordered for troops on the "west beach" . . . the [radio] order was given to the Fighter Command . . . two hundred miles away . . . WITHIN A FEW MINUTES Douglas Bostons were dropping a heavy pall of concealing smoke . . .
(news item)

Interesting!

Watch for radio use in the war news — you'll find it in the air — on the ground — and at home!

Without radio, the movement of war would still be anchored by telephone lines—the physical hazards of the courier and visual signals.

Now war moves swiftly over the whole face of the earth—instantaneous radio communication thru the ether instead of over copper wires has blasted the barriers of space and time.

So today all our radio production centers on war use.

But what of tomorrow—what effect will this have upon the future—after victory?

One thing is certain—it will revolutionize and speed the great new future form of transportation.

Radio has never been universally necessary in transportation before. In automobiles—on trains—it has been entertainment—in boats it has been a great aid but not an essential.

But today for the future, in that great, new universal transportation that is forming itself—the airplane—radio is essential as the engine itself.

And—mark this well—airplanes and radio are two of the four *great* industries destined to lead this country back to business normalcy after the peace is won.

Zenith's leadership in the radio industry has been established by a constant achievement of "firsts" Repeatedly, ideas "brand new" when Zenith "first" introduced them, later became essentials on all radios And that same "forward thinking" of engineers and factory and organization now concentrates on war production of the thing we know—radio—exclusively radio We are progressing—we learn every day—and this new experience will inevitably reflect itself when Zenith again produces for peace.

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welding. Laboratory experiments indicate that an improvement of as much as 20 percent may be made in welding.

Deflection of the arc is caused by magnetic forces produced by the electric current as it passes through the electrode (or welding rod), the steel plate being welded, and through the arc itself, the engineers said, or it may be caused by permanently magnetized plates.

"The electric arc is a flexible gaseous conductor and the presence of external forces causes the arc to be distorted and even be extinguished," Mr. Jenning explained. "When the arc is deflected, the joining metal doesn't transfer properly to the desired location. We have found that re-routing the magnetic forces acting on the arc is an effective way to combat arc blow."

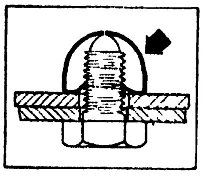
The horseshoe-shaped magnetic shunt is used in the case of heavy steel plates which are permanently magnetized. Made of two bars which are bolted together to provide a good magnetic path between the sides, this shunt is placed along the joint and changes the direction of magnetic forces in the work piece. When welding close to the end of a joint, a flat steel bar will serve as magnetic shunt.

SPRING NUT

Made in Acorn Shape,

Is Self-Locking

Extending inward from the base of a newly designed spring nut, now available in acorn as well as other shapes, is a series of fingers that surround the screw thread and grip on one thread in a self-locking assembly. A cross-section of one of these nuts, made by the Palnut Company, is shown in an accompanying drawing. This new unit, part of the company's line of formed steel nut and lock-nut fastenings, is available in three sizes.



Fingers formed in shell grip threads tightly

PIER FORMS

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of Laminated Fiber

Laminated, spiral-wound, specially constructed and wax-treated fiber tubes are now available in five standard diameters for use as concrete pier forms. These tubes, furnished in lengths up to 24 feet and in inside diameters from 9 to 13½ inches, are cut to length on the job, by hand or power saw, in a matter of seconds.

Such pier forms, known by the trade-name of Sonotube, are easy to handle, are easily set up in place, and need not be stripped off after the piers are set up.

GERMICIDE

Added to Cutting Oils, Protects Workers

Developed to be used by adding to cutting oils, a new liquid germicide is now on the market under the name of Cutacid. Application of four ounces of the liquid in 55 gallons of cutting oil makes a solution that destroys germs, thus protecting workers who may receive skin abrasions and cuts while performing machining operations.

BRIGHT STEEL

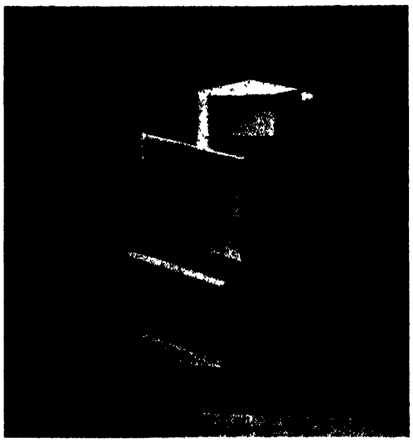
Assured by Use of Conditioner in Pickling Bath

A steel surface conditioner for use in either hydrochloric or sulfuric acid pickling baths results in a bright metal surface which is ready for immediate electroplating. It is claimed that the use of this surface conditioner, known as Surbrite, will reduce acid consumption and metal loss in comparison with pickling practices where plain acid is used.

NOTCHING UNIT

Maintains Punch and Die in Alignment

Where metal parts require a notching operation for bending or forming purposes, a new unit has been made available which can be used with any press of suitable capacity Nothing is attached to the press ram, the self-contained holder of the unit maintaining constant alignment of the punch and die.



Self-contained, cuts notches

These notching units, made by the Strippit Corporation, can be set up in series and standard or irregular notching patterns can be achieved in one stroke of the press ram.

UNIVERSAL VISE

Designed to Hold Work in Any Position

The time required for involved and complicated machine-tool setups can frequently be greatly reduced by the use of a universal type of vise which can be applied to drill presses, grinding machines, and other shop equipment. The most complex left and right compound angles can be produced literally by the twist of a dial.

Compound angles can be "dialed"

Among the accessories available for this vise, made by the F. & H. Manufacturing Company, is a pair of friction plates joined together by a ball and spring socket. These plates are designed for instantaneous clamping of work pieces whose opposite sides do not lie in parallel planes.

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Solderless Type Assures Durable Connections

A "plug type" terminal designed specifically for use on panel boards and rotary switches, on shipboard—or wherever plug-in wire connections are demanded — assures a durable, solderless connection. Manufactured by Aircraft-Marine Products, Inc., these terminals are available in straight and right-angle shapes for wire sizes 16 and 14.

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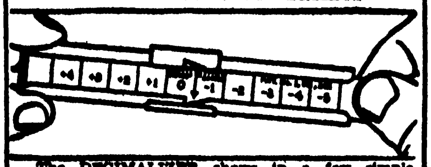

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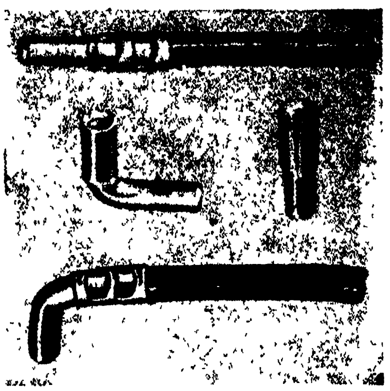

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FLAW DETECTION

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Sodium light, which has proved effective for highway lighting, is being used in several important war plants for surface inspection by microscope, because of its efficiency in the detection of pits, cracks, and flaws in materials. The sodium lamp is essentially an arc lamp, and differs from the incandescent in that it requires a special socket and individual control for each lamp.

The unusual perception of detail under sodium illumination is due to the monochromatic nature of the light, according to H. A. Breeding, of the General Electric Illuminating Laboratory. The eye, in common with other lenses, actually focuses only one narrow wave or color band at a time Other colors in the beam tend to fog the picture. Thus, minute details may be lost in examining an object under a light which contains all wave bands, in contrast to an examination of the same object under monochromatic light which contains only one wavelength. Also, a given amount of energy from sodium light produces several times as much illumination as the same amount of energy in white light.

As in the case of sodium lighting for night safety driving, monochromatic light for microscopic inspection is most effective when spread uniformly over a large area rather than concentrated in small bright patches. In this way an undistorted view of both size and shape of flaws present is obtained. For most effective results, the level of the illumination should be comparatively high, especially when the contrast between flaw and surrounding material is low.

It is helpful in searching for cracks and blow holes to treat the part with either a light-absorbing or light-reflecting dye, the dye depending on the nature of the surface to be inspected. The dyed surface should be cleaned thoroughly before inspection. This procedure increases the contrast between flaw and object to the point where extremely small flaws can be detected. In all cases it has been found necessary to block out as much sunlight as possible, in order not to destroy the monochromatic nature of the sodium illumination.

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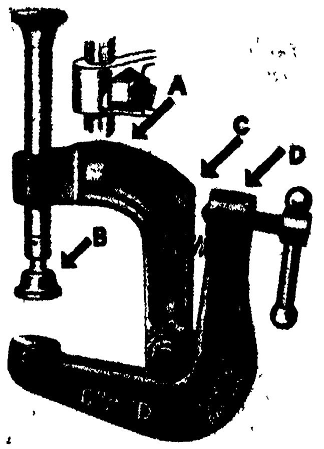
Quick-Acting Design Holds On Straight, Tapered Surfaces

The long screw of the standard type of clamp is replaced in the clamp shown in the illustration by a ratchet rod. In use, this clamp is placed in position, the ratchet rod is pushed down, and final tightening pressure is applied by the short screw shown to the right in the illustration.



Letters are referred to in the text; inset shows spring-loaded ratchet

The clamp includes two parts hinged together in an arrangement that prevents slipping on tapered or irregular surfaces. In the illustration, A indicates the spring-backed pawl, B the replaceable swivel in the end of the ratchet rod, and C the point of application of pressure by the screw D.

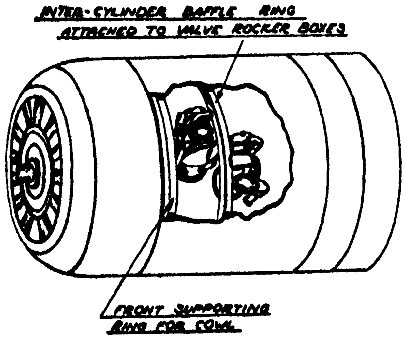
How Germany Does It

Powerful, Compact Airplane Engine Has a Pre-Designed Cooling System and Other "Built-In" Accessories

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

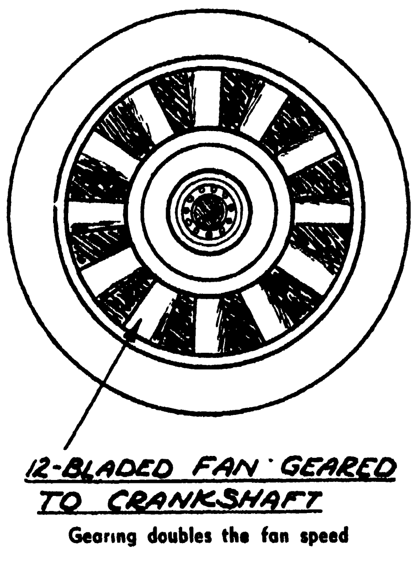
THE most powerful and probably the best air-cooled aircraft engines in the world are built in the United States, but there is a good deal to be learned from the German twin-row engine, the B.M.W. 801A, which has been described in *Flight* and other English technical journals. In the United States and in England we take an air-cooled engine and then fit to it cowling, cowling flaps, scoops, and other accessories. But the Germans have conceived the B.M.W. not just as an engine, but as a real power-plant unit, with pre-designed cooling and other accessories. As a result, the B.M.W. is surprisingly compact and clean, from an aerodynamic point of view.

Within a diameter of only 52 inches and an overall length of only 58 inches there is packed 1580 horsepower at take-off; 1460 horsepower at 16,300 feet of altitude, and 1280 horsepower at 18,500 feet. Of course, the B.M.W has neither the power nor the altitude characteristics of the P & W engine that is scheduled to equip the Republic Thunderbolt, but the packing of so much power in so small a volume is none the less remarkable. To achieve this small overall diameter the cowling encircles the 50-inch diameter engine closely. It is supported by front and rear rings and an inter-cylinder baffle ring, all attached to the valve rocker boxes by means of rubber-bushed bolts.


INTER-CYLINDER BAFFLE RING ATTACHED TO VALVE ROCKER BOXES
FRONT SUPPORTING RING FOR COWL

Partially cut-away view of the German B.M.W. engine, showing the cooling fan and two of the cowl rings

To make sure of cooling, particularly during the take-off period, the Nazi designers have introduced another innovation. At the front end of the engine the cowling is faired down to shroud a 12-bladed magnesium-alloy fan of 32 inches diameter. The fan is driven from the engine at nearly twice crankshaft speed, thus assuring an adequate air flow when the engine is running on the ground or in flight at slow speed. When the aircraft has a forward speed of 170 miles an hour, the fan is declutched and motored around by the air stream. At take-off there is a loss of 100 horsepower in running the fan, but this serious loss is more than offset by the positive air flow and the small-diameter, low-drag cowling. Exit of the air is by way of two circumferential slots controlled by a sliding ring and special mechanism gives uniform flow all through the engine and at exit. The air intake for the supercharger is completely inside the cowling and fed from the air delivered by the fan, which also helps in reducing head resistance By this combination of means, a smooth exterior of low aerodynamic drag is attained.



Gearing doubles the fan speed

Cylinders are arranged in staggered rows of seven each, with the lowest front and the uppermost rear arranged vertically. Details of construction are

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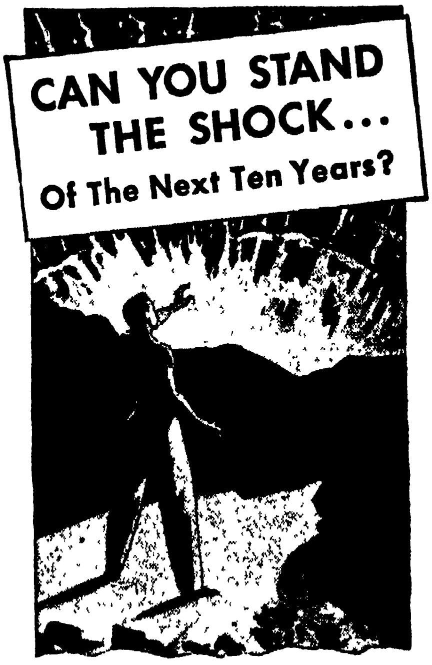
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interesting and the whole design appears thoroughly workmanlike. It is also interesting to learn that the exhaust pipes terminate in a flame damping fitting, but without shroud or screen to obscure glow.

There is, of course, a drawback to this compactness, coupled with inherent complexity, and inside the cowling there is a mass of pipes and accessories, which gives an impression of complexity and of difficulties in maintenance. But perhaps the Germans do not intend maintenance work to be carried out on the engine until the power plant is dismounted. At any rate, our designers would do well to study every bit of information that may be available.

FEAR AND HATE

Diminish and Increase

With Continuing Air Raids

Dr. V. L. Gruberg, writing in the English magazine, *Flight,* attempts to reduce the psychological value of the air raid to a formula and plots the intensity of various psychological factors against time. His conclusion is that with repetition of the raids, the curve of fear gradually descends while that for hatred rises. Apparently Dr. Gruberg's belief is substantiated by studies of the Spanish civil war and other conflicts, that the air raid makes the civilian population hate so much that they are more determined than ever to continue the fight. That is precisely where the Germans made their great mistake. They thought they could reduce England by inducing fear in the civilian population and failed. The British are on far sounder ground because their raids are primarily for the destruction of war production establishments, and not for the killing of the civilian population, which is incidental —A. K

THE THUNDERBOLT

Saves for Weight, Compares

Favorably with German Fw. 190

Germany's latest single-seater fighter, the Focke-Wulf Fw. 190, of which we read quite frequently in the press, is equipped with the B.M.W. 801A, previously described in these columns

The Fw. 190 is remarkably clean. Owing to the compactness of the engine, the fuselage does not show the somewhat "tubby" appearance which we note on fighters having engines of greater diameter. There is a total absence of excrescences to mar the beautiful lines of the ship. The Fw. 190 is powerfully armed with four cannons and two machine guns. But, what is more remarkable, is the compactness of dimensions. The span is only 34 feet, 5 inches; the wing area is only 194 square feet; the gross weight only 8580 pounds. With its powerful engine and relatively small size and its two-speed supercharger, the machine has a remarkable climb of 3000 feet a minute at a 4000 foot altitude, and at 18,000 feet, with the supercharger in high gear, the speed is 375 miles per hour.

With greater speed, greater ceiling, more powerful armament, and more power in its engine, our Thunderbolt is certain to be more than a match for the Fw. 190. But the Thunderbolt is also bigger, weighs 13,000 pounds, according to the New York *Times,* and is likely to be more heavily loaded per square foot of wing area. Our Thunderbolt will be immeasurably superior to the Focke-Wulf at great altitudes. At medium altitudes it will be faster and more powerful, but greater weight also means less maneuverability. We wish our Thunderbolt could retail all its fire power, all its armored protection, all its high ceiling characteristics, but be just a trifle lighter and more meneuverable for moderate altitude fighting. But, in all probability, other of our ships already fill the gap perfectly —A. K.

A GERMAN VIEW

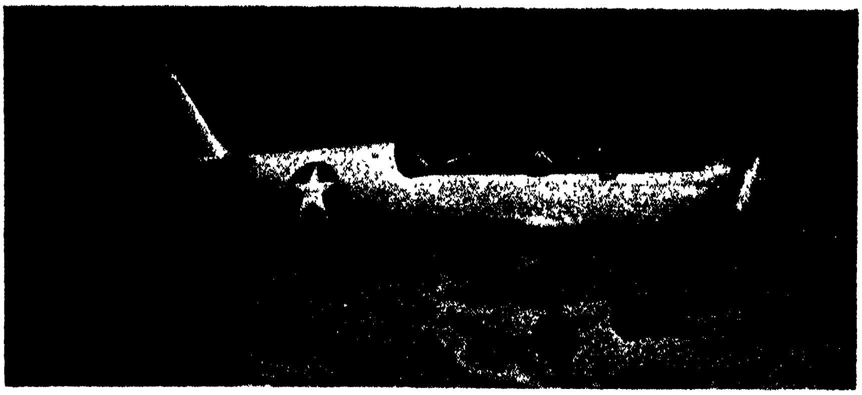
Shows Striking Similarity

In Research Work

Somehow or other, belligerent nations secure each other's technical or scientific papers and study them with the closest attention. Thus, *Flight,* London, reprints with pride a paper on "Topical Aircraft Problems" read by Professor Dr. Ing. Gunther Bock before the Libenthal Society of Berlin, and in America the paper is hailed with the same eagerness as in London. Yet nothing very novel is discoverable Apparently the Germans are thinking on similar lines to ourselves.

Thus, we have frequently mentioned in these columns that if the flow could remain laminar over the greater portion of the wing, the drag could be very much reduced, and that the path of progress lay in so shaping the wing as to make the suction more uniform over the upper surface of the wing, so as to delay change from laminar to turbulent flow. Professor Bock advocates exactly the same line of research. Another problem, according to the same German authority, is to eliminate the windshield and blend very large windows into a streamline form. Such practice also coincides with ours.

All the nations at war are seeking



No critical high-alloy steel in fittings or standard parts

greater power output than their enemies: Let us quote from the German authority: "This effort has led, in Germany, to going over from the carburetor engine to the injection engine On its passage through the carburetor, the air is, as is well known, throttled and therefore energy is removed. In the injection engine the carburetor is omitted, and the fuel is injected direct into the cylinder on the induction stroke by special pumps The throttling losses of the carburetor therefore disappear, and we obtain, by going over to injection, an increase in power output of 4 to 10 percent."

The no-thrust radiator is agitating the Germans just as it is us: "The air which passes through the radiator is heated and expands On account of this, it leaves the radiator cowling with greater velocity than it would have in the case of a cold radiator. This increase in speed produces a thrust, as in the case of a rocket."

Considerable attention is given by the Germans, as by ourselves, to utilizing the exhaust gas energy for supercharging, and in general to utilizing exhaust gas efflux for producing thrust.

All of this reads remarkably as if one of our own engineers had read a paper before the Institute of Aeronautical Sciences. It indicates that technologists everywhere are apt to tackle the same problems at about the same stage of evolution—*A K*

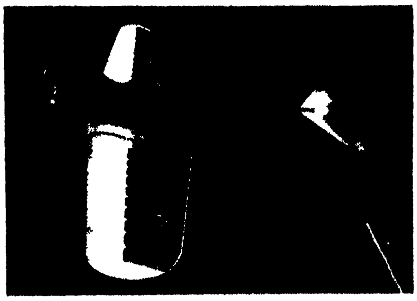
TRIM TRAINER

Ryan-built Plane Made of "Ersatz" Materials

The Ryan PT-25 Military Primary Trainer is an excellent training plane, well adapted for its purpose in every way, and the result of many years experience in the construction of such aircraft. Powered with a six-cylinder opposed Lycoming air-cooled engine, it has speed and maneuverability. Both student pilot in the front cockpit and instructor in the rear cockpit enjoy excellent vision.

But what is perhaps more important at this time is the fact that the PT-25 dispenses with aluminum alloys and all other strategic materials, except those which appear in the cowling and, of course, in the engine, which could hardly be built of wood.

Moreover, the design is a splendid embodiment of the plastic-bonded plywood construction which is assuming such great importance today The smoothness of line has been obtained with a minimum of compound curved surfaces, so that a manufacturing method is employed which does not require the use of ovens or baking, and cold-setting urea formaldehyde glues are used throughout The fuselage is of the monocoque stressed skin type with ten bulkheads formed of laminated spruce, and is plywood covered Although well streamlined, the fuselage has such lines that manufacture is easy A unique jig allows the workman to go inside the jig and unbolt the holding forms after fabrication, so that all that is then necessary is to slide the completed section off the jig. One of our photographs shows a view of the wing construction. Each wing panel is built up from a single wood spar with wood ribs and a plywood-covered nose torque box Fabric covers the rest of the wing. This type of construction reduces labor to a minimum and, because the weight of the wing is far forward along the chord, flutter is not likely. The simple construction is apparent from the photograph.—*A. K.*



Plywood and other "ersatz" materials play a big part in wings and fuselage

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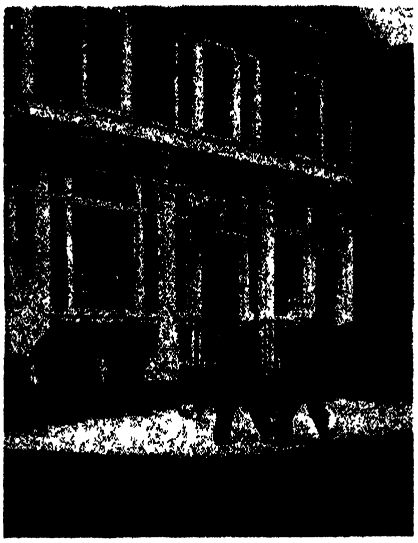
CAMERA ANGLES

Conducted by JACOB DESCHIN, A. R. P. S.

Your Town in Wartime

KEEP a picture diary of the changes going on in your town during the course of the war. It will be a valuable historical record not only for your own family and friends but, if well done, for the town itself. For example, this shot was made in Provincetown on Cape Cod, where the war has had a marked effect on the pattern of the town's life and ways. A Coast Guard training station there has made Coast Guardsmen part of the regular population and restrictions due to wartime necessity have limited the fisherman's choice of fishing areas. Something of the natives' reaction to the change has been caught in this picture.



"Them Coast Guard Fellers"

Greeting Card Time

CHRISTMAS is on its way again and greeting card making is in order. This year greeting cards are more important than ever, particularly for the boys in the camps, and pictures will be appreciated by the fighting men more keenly. For the boys farthest from home and unable to get away for long enough periods to make the round trip to home and back to camp, pictures of family and friends will have a real meaning, like a visit from the folks. Whereas formerly a decorative scene of some sort did the trick fairly adequately, this year send faces.

Expose Color for Shadows or Highlights?

THERE was a rule once, that seemed as fixed as fate, that one should expose for the shadows and let the highlights take care of themselves. Today, some doubt the accuracy of this and in certain quarters it is even suggested that we should expose for the highlights instead. However this may be for black and white, in color, where the range of illumination should never exceed four to one for reasonably good color rendition, it is advisable to read the highlights. If we were to expose for the shadows in Kodachrome, our highlights would be washed out; if we expose for the highlights, the shadows are rendered satisfactorily enough. The one exception to this rule might be the occasion when the shadows predominate and the highlights occupy only a small part of the scene. Then, obviously, our shadows should get the major attention and the exposure meter should be directed toward them to obtain the proper exposure.

Lantern-Slide Lectures

NOTHING can teach a fellow how to make better pictures so well as the constant observation of prints that have won salon recognition time and time again. Realizing this, the Metropolitan Camera Club Council, of New York, has instituted a project under the direction of C. T. Boyles, A R.P.S., designed to provide camera clubs with lantern-slide lectures showing reproductions of prints that have been hung in outstanding American photographic salons. Constructive criticism will accompany the prints The photographing of the originals was done by J. Ray Hoagland, first vice-president of the Council, and Ernest F Draper, technical advisor

Efficient Washing

LOOKS pretty, but is it efficient? Of course not. The illustration is an exaggeration, naturally, but have you ever noticed how careless some folks are about washing roll film in tanks? They let the water run in from the faucet and hope that somehow, willy-nilly, the films will get washed. The water has to get straight

Pretty but futile

to the bottom of the tank and with enough force to drive the hypo out. The only way to do this effectively is to use a hose let down to near the bottom of the tank. The water will then force the hypo up over the top of the tank and out.

Copying Rough Prints

PRINTS on rough or matt surfaces are difficult to copy because the results usually show the texture of the paper, making the copy a rather unsatisfactory job. One suggestion to avoid this is to rub the print down with a good coating of petroleum jelly (white Vaseline). Apply the coating evenly. Illuminate the print so that reflection is prevented and that even illumination is produced. The grain is greatly minimized if not eliminated entirely. The glazing action over the paper texture does the trick

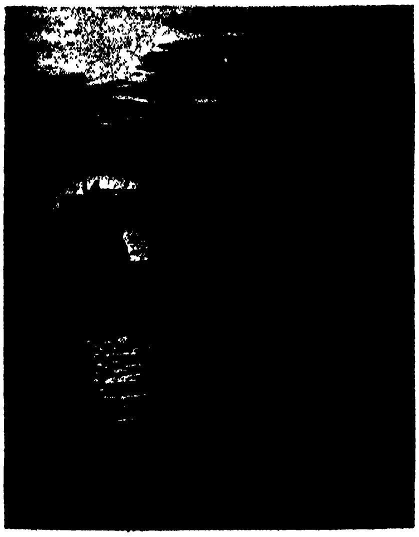
Comparing Lens Apertures

HERE'S a handy table (Bell & Howell) which both movie and still fans should find useful. Comparing aperture *f*/2.5 with *f*/3.5, for example, we find that the coefficient of *f*/2.5 is .06; that of *f*/3.5 is .12. The latter being double the former, the *f*/2.5 aperture is twice as fast as *f*/3.5. Figures starred represent the true, full stops, each of which admits 100 percent more light than the next smaller true stop. For all practical purposes *f*/1.5 is equal to *f*/1.4, and so on:

Coefficient of Illumination	F Stops	Coefficient of Illumination	F Stops
.01	*1.	.30	5.5
.02	*1.4	.31	*5.6
.03	1.7	.40	6.3
.04	*2.	.64	*8.
.06	2.5	1.21	11.
.07	2.7	1.28	*11.3
.08	*2.8	2.56	*16
.12	3.5	4.84	22
.16	*4.	5.29	*23
.20	4 5	10.24	*32

Sunset Silhouette

ONE of the reasons for the failure of many sunset pictures is the lack of interesting foreground material. Choose a viewpoint where you can include part of a boat, the wharf, or some other object, place it appropriately in the picture area, and you have something far superior to the mere sunset shot, which includes only sky and water.



"Haiti Sunset"

Record Into Pictorial

THERE'S no law that says a record shot made for the sole purpose of illustrating a fact cannot also serve the uses of pictorialism. Take, for example, the picture of the girl drawing the bow string. This was one of a series of pictures made to illustrate the technical details of archery. Most of the pictures in the project were useful only as part of the complete set, but here and there opportunities presented themselves for special pictorial treatment. A print such as this, for example, can be finished off in salon style, with toning and all the fixings

For record and salon

Prints on China

HERE'S an idea for those who have been wanting to print a picture on china or glassware. Chromatone Stripping Paper, ordinarily employed in color printing, will serve for black-and-white printing as well. Make your print as usual, strip the emulsion from the base, then fix and wash as you would when making ordinary prints. Apply a coating of gelatine to the china, glass, or whatever, then mount the print. When perfectly dry, cover with a coat of clear waterproof varnish.

Pictures for Reproduction

A FAVORITE method with engravers in judging how a print will reproduce in a publication, is to look at the print with eyes half closed. This compresses the tone scale and reduces the values to somewhere near the tone range that can be expected in the reproduction. Delicate differences between highlights, for example, tend to merge into a single tone, indicating that a new print should be made to show more contrast.

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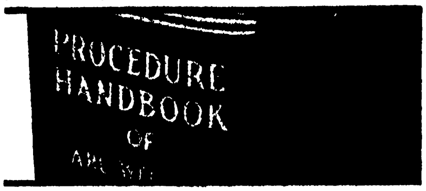

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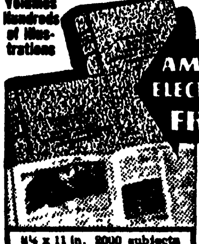

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and "Amateur Telescope Making—Advanced"

In this department, in our September number, we showed a photograph of the huge worm wheel for the R. A. drive of the 200" telescope. Through the courtesy of *Modern Machine Shop*, Cincinnati, we make available to our readers an account, written by Robert Clark, of the exceedingly refined and prolonged job of cutting the teeth on the gear within a tolerance of one second of arc (1/1,296,000 of a circle).

Only once in the history of gear cutting has there been any record of the cutting of a worm gear weighing ten tons, having 720 — ¾-pitch teeth within an overall tolerance of 0.0001". To three men go the credit for this feat; Mr. G. Sherburne, Superintendent of the Astrophysics Machine Shop at the California Institute of Technology, and his assistants, Mr. Tom Weir and Mr. Lawrence Sills, machinists.

The gear, one of three identical gears cut, is used to drive the mechanism which positions the 200" telescope.

The architect's drawing (Figure 1) shows a cross-section of two of the gears which are employed to position the telescope in right ascension. One of the gears makes it possible to move the telescope quickly in making a setup; the other is the final gear in a set which swings the telescope at the exceedingly slow speed required to follow a star.

The drive gear, which is 14'3" diameter, is of cast iron with 0.25 percent of molybdenum added to give it the necessary 200 Brinnell hardness.

One of the initial problems was the design of a support for the blank which would make it possible to keep the side play down to the error allowance of 0.0001" while the teeth were being cut The first job, then, was to construct a bearing and spindle that would meet these requirements. This was done by machining the spindle so that it had two tapered surfaces—one near the top, the other near the bottom—that were lapped into two tapered bearings which were made to take them.

A small pilot shaft at the end of the spindle rested on a special thrust bearing which could be adjusted. By slightly raising the spindle and gear, the coefficient of friction could be lessened to prevent the spindle from freezing in its tapered bearings, although, even with this setup, the matter of lubrication to the spindle caused considerable trouble. Even the lightest oil film would permit side play of more than 0.0001". Indeed, the capillary action of the light oil was sufficient to raise the spindle, gear, and structure—weighing more than 10 tons— as much as 0.0001". The vertical movement was not of much importance, but the side play was. However, by the expedient of machining facets in the tapered sections of the spindle, the error caused by the oil film was eliminated to within the tolerance allowed.

Adequate temperature control could be obtained only by the construction of a room about the whole job. Air conditioning equipment was then installed, with which the temperature of the room could be controlled within plus or minus 1° F. When ready to run, the room temperature was maintained at 74° to 76°.

Calculations that had been made showed than any equipment for indexing, if placed upon the gear blank itself, would develop a warping action due to the stresses set up by the cutting, and thus would ruin the accuracy of the job. To eliminate this difficulty, an auxiliary plate of approximately the same diameter as the gear was made and securely bolted to the blank so that measurements could be taken from it for the milling operation.

In order to space the teeth properly, buttons of hardened tool steel, ground to within 0.0001" of a given size, were mounted on the plate. Dial gages were then used to ensure perfect location.

[Note by Ed., Scientific American.—These "buttons," from here on frequently referred to, are the "toolmakers' buttons" which are familiar to mechanics. Whenever high-precision accuracy in the positioning of a cutting or grinding operation is called for, methods such as making marks by ordinary measuring are not sufficiently close. There must be some additional method of "correcting the aim" by a series of closer and closer approximations. This is done by the use of "toolmakers' buttons." First, the point is determined as closely as possible by ordinary methods. A center-punch mark is made and a hole is drilled and threaded. The button, a small steel cylinder (several of which show in Figures 2 and 4) having a vertical, central hole, is then attached by means of a machine-screw.

Figure 1: Left: The drive in right ascension

Figure 2: Right Positioning the teeth with buttons

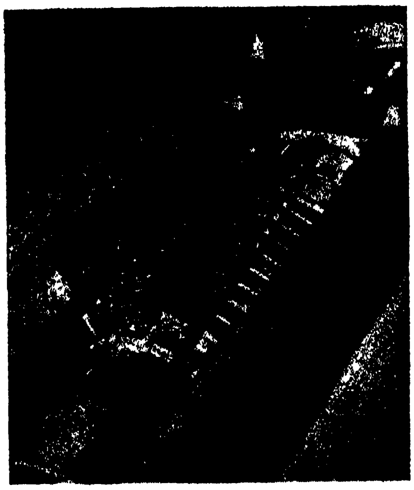

Figure 3: **Cutting the teeth**

The hole in the button is purposely made larger than the machine-screw, so that the button will have side play. If, now, the screw is adjusted just snugly, but not too tight, the button may still be shifted in position within small but sufficient limits. This is done by delicately tapping on its side with a light tool. When the final measurement, made in the present instance by means of a long tram rod, or trammel, indicates that the button is positioned as closely as possible, the screw is set up, and the machine is adjusted to cut in relation to this button, the button itself being then removed to permit completion of the operation. Since the dimension of the button enters into the measurements and calculations, this must of course be accurately known.]

The process of locating the buttons on the button plate presented some interesting problems. The placing of the first one was, of course, easy, but locating the second one, which was to be 180° away, was another matter. All the buttons were mounted on an eccentric, which allowed them to be adjusted slightly. The second button was roughly located with the aid of a straight-edge lined up across the center of the plate to within perhaps 0.004" to 0.005". Then the slow, tedious task of adjusting the buttons at points exactly 180° apart, within 0.0001", began.

Two dial indicators graduated to 0.0001" had already been set up 180° apart, positioned on ground ways. The first indicator was adjusted to the leading edge of the first button, and set to read zero. The second indicator was then set on the second button and set to read zero. Then the gear was revolved 180° and new readings were taken. Of course, the readings were off.

The buttons were then adjusted to compensate for the error, as closely as it could be judged, and the gear was revolved again. The error was less the second time, but still over the allowable limit. Again the buttons were adjusted and again the gear was revolved the 180°. After many more trials and adjustments, the buttons were spaced within the allowable limits.

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The exact spots for these buttons had been determined by calculations and a tram rod had been made to measure the distance from the first two buttons. From the calculations the buttons for the 90° positions were set to within 0.004" or 0.005". Then the tram rod was used.

At one end of the tram rod was a hardened "V," made to fit the buttons. At the other end was a dial gage, reading to 0.0001". The tram was well insulated by wrapping it with paper, and a wooden handle had been incorporated into the construction so that the heat from the machinist's hands would not introduce errors in the readings. Just one degree of temperature shift was found to change the reading as much as 0.0002".

The next move was to adjust the two buttons in the 90° positions so that, by using the tram in any one of the four quadrants of the gear, the error was brought within the allowable limits. This process was repeated with another tram for the 45° positions of the third set of buttons, and other trams of the correct lengths were used until all of the 144 buttons had properly been spaced on the plate. This allowed a button for every fifth tooth on the gear. When the time came for milling the intermediate teeth, an insert of four buttons, shown in Figure 2, was used.

With all the buttons properly located, it was time to cut the first gash. Then the gear was revolved 180° to eliminate accumulated error, and the second gash was made. Then to the 90° position, and so on. The rough milling was done in two stages, taking two straight cuts and leaving 0.007" in the second cut to be removed by the hobber in the finishing cut. The hobbing operation is illustrated in Figure 3.

It was found that, during the milling, the heat generated by the cutter materially affected the accuracy of the operation. To relieve this situation, a hollow cutter arbor was used through which water at a controlled temperature could be circulated.

After the first roughing cut had been made for all 720 teeth, the method of checking for accuracy was changed. A microscope was anchored in position over the handwheel of the worm, which was graduated in 0.0001", and a dial indicator was positioned so that it would touch a tooth some distance away on the periphery of the gear as shown in Figure 4. As the gear was always revolved in one direction only, no correction was necessary for backlash. Upon checking and rechecking it was found that the error between any one tooth and any other was only 0.0001".

When the gear blank was made, it had been split horizontally, with the idea that the two sections could be unbolted after the rough milling had been completed, so that the top section could be revolved 180° before the finishing cut was taken. This would, of course, have increased the accuracy. However, by using the method and care described above this action was rendered unnecessary.

The milling operations took ten months and the finish hobbing operation took three weeks. Two and one half years in all were required to cut the teeth on the three gears. As the work progressed from one gear to the next, the accuracy improved. For instance, in the cutting of the first gear there was an error in one of the quadrants of 0.0004". This error made that particular quadrant unusable. However, the three remaining quadrants were within the allowable tolerance and this gear is now used for the North and South declination with the bad quadrant at the top of the gear where it is never used.

This completes the abstract from Robert Clark's account of the job for the 200". In referring to Figure 1 he terms it "the architect's drawing," which is quite correct, but the architect happens to be Russell W. Porter. At that, Porter is an architect—or was so educated.

Those who have *created* a setting circle—that is, not simply taken off the marks from another divided circle or transferred them from gear-tooth spacings (which is about the same thing) but who have themselves divided a circle out of the void and nothingness, will recognize the almost exact similarity of the method employed with the method described above. The following is a short additional note written for the most recent printing of "A.T.M.A." and inserted on page 302. It briefly explains this method of creating a setting circle, and incidentally may be clipped out and pasted in earlier printings of "A.T.M.A." by those who own that book. It runs—

"Editor's Note: For theoretical data on setting circles, see chapter on 'The Divided Circle,' in Martin's 'Optical Measuring Instruments.' Also see article on

Figure 4: **Measurements refined to microscopic precision**

TECHNIQUE OF PLYWOOD

By **CHARLES B. NORRIS**

Plywood demand is skyrocketing in the production of wartime housing, airplanes, boats, and other defense needs, yet specific information on the material itself is difficult to find. Here, between the covers of a plastic-bound book, has been gathered technical information on all phases of plywood manufacture, specially written for engineers, designers, and users of plywood. (249 pages, 5 by 7½ inches, tables and drawings.)—$2.50 postpaid.

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Divided Circles,' in Glazebrook's 'Dictionary of Applied Physics,' Vol. IV. The latter explains the methods used in one example chosen, for inscribing 4320 divisions, one for each 5 minutes of arc, on a 48″ circle, within an accuracy of ½ second. The method is one of trial and error in a series of closer and closer approximations.

"A crude suggestion of the principle used can be had by tacking a circle of cardboard at its center to a board. Place a reference mark (representing the cutter) on the board adjacent to the edge of the circle and mark the periphery of the circle in continuation of it. Call this zero. Select the 180° point on the circle by approximate estimate. Make a tentative 180° mark, and continue it on the board. Now rotate the circle till the 180° mark lies next to the cutter. The true 180° point should now be halfway between the rotated zero mark on the circle and the nearby mark on the board.

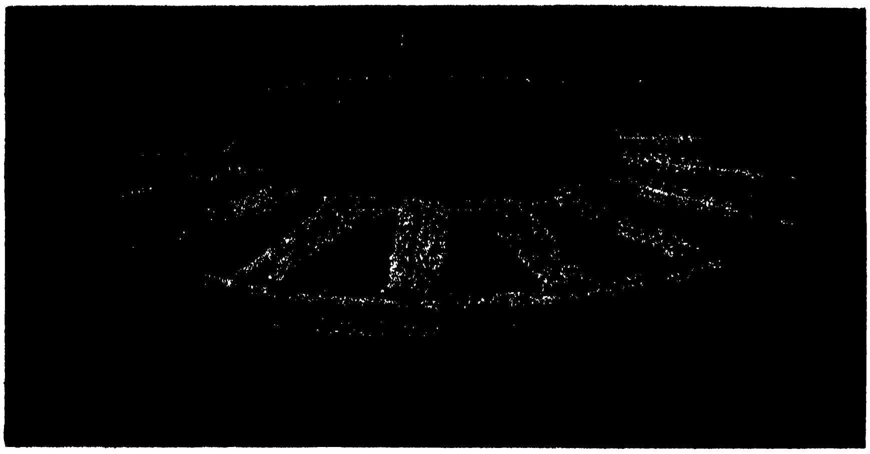
Figure 5: The finished gear with 770 teeth of ¼ pitch

"Estimate new marks for a closer trial and repeat the cycle; and so on.

"Using this as a starter, in the example mentioned above, the 90° and smaller divisions on the 48″ circle were filled in by similar principles, and it all required six months of tedious slavery for the 4320 divisions. The approximations soon fell within the field of compound microscopes powerful enough to detect errors of one tenth second, or 1/86,000 inch.

"Gluttons for this general type of masochism will find in the same volume of Glazebrook a 10-page article on 'Diffraction Gratings, the Manufacture and Testing of,' by Dr. J. A. Anderson. Asked how the two jobs, the 48″ circle and the construction of a ruling engine, would compare in difficulty, Dr. Anderson stated that the ruling engine job would be far more difficult, since so many more factors enter into it—not alone equality of spacing, but length and parallelism of grating lines."

End of "A.T.M.A." supplementary note.

This is not to say that the circle job is easy, and similarly for the big worm wheel job, but only that the ruling engine job is super, hyper, ultra. The other jobs are merely super, hyper.

EXCHANGE: From Peter Dawson, Care Dr. A. C. Ainsley, Greylands, Victoria Road, West Hartlepool, County Durham, England, comes the following: "Could you find two or three young fellows, at about the same stage as me in telescoptics, to correspond and keep the interest aglow, now that the difficulty of obtaining materials over here is increasing. I am only a very green amateur, aged 18, and my interest began three years ago. During this time I have been studying physics (with particular accent on optics) and hope to go to University to continue, in October. I have completed a 2½″ refractor, the O.G. of which I did not work—I just did the engineering and woodwork. I have started a 6½″ mirror and am at present grinding. I have studied that excellent book 'A.T.M.,' also 'A.T.M.A.' I am also a keen trout fisher. Do you think you could wangle it so that my correspondents are cursed with this plague too?"

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THE FUTURE OF AIR TRANSPORTATION is an eight-page mimeographed folder which provides a broad survey of current developments in the field of air cargo transportation and outlines the potentialities of this part of the aviation industry in peace-time years. *Estabrook & Company, 40 Wall Street, New York, New York.—Gratis.*

INDUSTRIAL DIAMOND TOOLS is a four-page illustrated folder which gives general information on industrial diamonds and their characteristics, on where they are produced, and on a series of wheel-dressing tools. *Christensen Diamond Tool Company, 3683 East Willis, Detroit, Michigan.—Gratis.*

MACHINING ALCOA ALUMINUM is a 48-page booklet for those who are interested in this particular subject for immediate use as well as for planning for the future. Request this booklet on your company letterhead. *Aluminum Company of America, Pittsburgh, Pennsylvania.—Gratis.*

PLASTICS is an eight-page booklet illustrating and describing the manufacturing process, compression molding, and uses of phenolic plastics and resins. Given also is a brief review of recent books and suggestions as to sources for further comprehensive study of the subject. *Durez Plastics & Chemicals, Inc., North Tonawanda, New York.—Gratis.*

PATENTS, CONGRESS AND THE NATION, a statement by the Boston Patent Law Association, is a 12-page pamphlet prepared to place before interested people the facts of the attack on our patent system which has been fomented by a group of men who apparently have a very slight appreciation or understanding of the value and benefits of the system. *The Boston Patent Law Association, Boston, Massachusetts.—Gratis.*

THE OBSERVER'S HANDBOOK for 1943 contains data on the planets and other astronomical phenomena, month by month; also lists of double and multiple stars, four star maps, an ephemeris of the Sun, times of moonrise and moonset for every day of the year for four selected latitudes, and miscellaneous astronomical data to the extent of 80 very useful, practical pages. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College St., Toronto, Ontario, Canada.—25 cents.*

75,000 RPM AT YOUR FINGERTIPS is a four-page folder describing a new air-driven grinding wheel which turns at that speed. The wheel is designed for use by die makers, industrial model builders, machinists, and so on. *Onsrud Machine Works, Inc., 3900 Palmer Street, Chicago, Illinois.—Gratis.*

COMBUSTION EFFICIENCIES AS RELATED TO PERFORMANCE OF DOMESTIC HEATING PLANTS is a 30-page booklet concerned with all phases of the subject of its title, and with definite types of fuel. The text is supplemented by a number of pertinent charts and tables. University of Illinois Bulletin No. 42, Circular Series No. 44. *University of Illinois, Urbana, Illinois.—40 cents.*

HAND-FIRING OF BITUMINOUS COAL IN THE HOME, by Kratz, Fellows, and Miles, of the Engineering Experiment Station at the University of Illinois, offers practical suggestions to householders who have been forced to change from smokeless fuels to bituminous coal in the same equipment. *University of Illinois, Urbana, Illinois.—25 cents.*

A GUIDE TO BETTER BEARING LUBRICATION is a 28-page booklet, illustrated with a number of drawings and charts, which treats the functions of lubrication, oil lubrication, recommended viscosities, circulating systems, grease lubrication, grease supply systems, and so on, for ball and roller bearings of various types. Particularly stressed are those features which, coupled with lubrication, insure longer life for machinery. *SKF Industries, Inc., Front Street and Erie Avenue, Philadelphia, Pennsylvania.—Gratis.*

KEEP 'EM WORKING is a 46-page illustrated booklet essentially designed to aid owners of Caterpillar products in getting the most out of their machines. It goes into considerable detail on the care and maintainence of such equipment. Request Form No. 7609. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

SIL-FOS AND EASY-FLO is a 16-page bulletin, illustrated with a large number of photographs giving details of a low-temperature brazing method using silver alloys. This method can be applied to ferrous, non-ferrous, and dissimilar metals, with speed and economy as important factors. *Handy & Harman, 82 Fulton Street, New York, New York.—30 cents.*

REPLY TO BEWILDERMENT, by A. W. Robertson, is a 16-page discussion of democracy and the nature of wartime leadership. The text is the answer to a letter received by the author, in which a request was made as to the definition of the duties of patriotic Americans. *Westinghouse Electric & Manufacturing Company, 306 Fourth Avenue, Pittsburgh, Pennsylvania.—Gratis.*

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